C. Francis –

1856.

INSECTO-THEOLOGY:

OR,

A DEMONSTRATION

OF THE

BEING AND PERFECTIONS OF GOD;

FROM A CONSIDERATION OF

THE STRUCTURE AND ECONOMY OF

INSECTS.

ILLUSTRATED WITH A COPPERPLATE.

Friedrich Christian

BY M. LESSER:

WITH NOTES,

Peter

BY P. LYONET.

EDINBURGH:

Printed for William Creech; and T. Cadell, Jun. and W. Davies, *London.*

1799.

ADVERTISEMENT.

BEFORE entring on the perufal of the following Work, it will not perhaps be difagreeable to the Reader, to have fome account of the authors of it.

Of the learned and pious LESSER few particulars are known. He was of Nordhaufen in Germany, and publifhed in 1736, a LITHO-THEOLOGY.

Of the author of the NOTES, we are enabled to give the following account, which was publifhed in the Gentleman's Magazine for September 1789:—

MR PETER LYONET, fecretary of the Cyphers, translator and patent-mafter to their High Mightineffes, was born at Maeftricht in 1706, and was defcended from a very refpectable and ancient family in Lorrain. His anceftors were frequently obliged by the wars and troubles occafioned by the Reformation, to abandon their habitations, and their native country, on account of their zeal for the reformed religion. His great grandfather, after having feen his eftates and poffeffions deftroyed and burnt to afhes, and his wife and all his children murdered, was at laft reduced to the neceffity of flying. He took refuge in Switzerland, where he was afterwards re-married, and had by his fecond wife a fon, of whom was born Benjamin Lyonet, French minifter at Houfdon, the father of our author.

 Mr

Mr Peter Lyonet had ſcarcely attained his ſeventh year before he diſplayed an uncommon ſtrength and agility in all bodily exerciſes; but he was not leſs diligent in the improvement of his mind. Being placed at the Latin ſchool, he learned chronology, and exerciſed himſelf in Latin, Greek, and French poetry, as alſo in Hebrew, Logic, and the Carteſian Phyſics. He was particularly fond of the ſtudy of languages, and underſtood no leſs than nine, living and dead; *viz.* of the former, beſides the Dutch and French, the Italian (which he had acquired without the aid of a maſter,) the Spaniſh, German, and Engliſh. Having entered the Univerſity of Leyden, he ſtudied the Newtonian Philoſophy, Geometry, Algebra, &c. but his father deſiring he ſhould attach himſelf to divinity, he reluctantly abandoned the former ſtudies, as his paſſion for them was not eaſily to be overcome. He at the ſame time applied himſelf to anatomy, and alſo to muſic and drawing. He began afterwards to practiſe ſculpture, and performed ſeveral pieces in wood, one of which in particular, which is preſerved, is uncommonly admired by the artiſts. It is a baſſo relievo, cut in palm-wood, repreſenting Apollo, with the Nine Muſes; a moſt gloririous maſter-piece, and which the painter Van Gool, in the ſecond volume of his "Review of the Dutch painters, &c. under the article Lyonet, ſtyles a 'wonder-piece.' It excited alſo the admiration of the painter le Chevalier de Moor. After this, he betook himſelf to drawing portraits of his friends from life, wherein, after three or four months practice, he became a great proficient. Having attained the degree of candidate in divinity, he reſolved to ſtudy law, to which he applied himſelf with ſo much zeal, that he was promoted at the end of the firſt year. On this occaſion he delivered an academical treatiſe on the proper uſe of the torture, which was publiſhed, and gained him the eſteem of the learned. Arrived at the Hague, he undertook the ſtudy of decyphering, and became ſecretary of the cyphers, translator of the Latin and French languages, and patent-

maſter

maſter to their High Mightineſſes. Meanwhile, having taken a ſtrong liking to the ſtudy of inſects, he undertook an hiſtorical deſcription of ſuch as are found about the Hague, and to that end collected materials for ſeveral volumes; and having invented a method of drawing adapted thereto, he enriched this work with a great number of plates, univerſally admired by all the connoiſſeurs who had ſeen them. In the year 1742 was printed at the Hague a French tranſlation of the following work. The love of truth engaged Mr Lyonet to defer the publication of his above-mentioned deſcription, and to write the Notes now tranſlated. This performance cauſed his merit to be univerſally known and admired. The celebrated M. de Reaumur had the French tranſlation reprinted at Paris, not more on account of the work itſelf, than of Mr Lyonet's obſervations; and beſtowed on it, as did alſo many other authors, the higheſt encomiums. He afterwards executed drawings of the freſh water Polypus for Mr Trembley's beautiful work publiſhed in 1744. The ingenious Wandelaar had engraved the firſt five plates, when Mr Lyonet, who had never witneſſed this operation, concerned at the difficulties he experienced in getting the remaining eight finiſhed in the ſuperior ſtyle he required, reſolved to perform the task himſelf. He accordingly took a leſſon of one hour of Mr Wandelaar, engraved three or four ſmall plates, and immediately began upon the work itſelf, which he performed in ſuch a manner as drew on him the higheſt degree of praiſe, both from Mr Trembley and from many other artiſts, particularly the celebrated Van Gool already named, who declared that the performance aſtoniſhed not only the amateurs, but alſo the moſt experienced artiſts. The authors of the "Bibliotheque Raiſonnée," 1744, have likewiſe certified their admiration of him; for after a long panegyric, they expreſs themſelves thus; "We may juſtly apply to him, what Fontenelle ſomewhere ſays of the famous Leibnitz: "Of many Herculeſſes antiquity made only one, but of a ſingle Lyonet, we may make many learned men."

In

In 1748 he was chosen member of the Royal Society of London. In 1749 he began, by mere chance, his amazing collection of horns and shells, which according to the universal opinion of all travellers and amateurs who have visited it, is at present the most beautiful, and certainly one of the most valuable in Europe. In 1753 he became member of the newly established Dutch Society of Sciences at Haerlem; and in 1757, after the celebrated M. le Cat professor of Anatomy and surgery, and member of almost all the principal societies of sciences in Europe, had seen Mr Lyonet's incomparable "Traité Anatomique de la Chenille qui ronge le Bois de Saule," with the drawings belonging to it (which work was afterwards published,) he was elected member of the Royal Academy of Sciences of Rome, whereof M. le Cat was perpetual secretary. Mr Lyonet's design in the compiling of that work was, among other things, to publish an anatomical description of an insect, as extensive and complete as any existing of the human body, which had hitherto never been effected, although several ingenious men have attempted something of this kind, but have however produced nothing more than weak and even faulty essays.—Of the praise and admiration expressed of our author in many respects (but particularly on account of the last mentioned work) by many celebrated writers, and in almost all countries of Europe, we shall state these extracts.

1. From the 'Bibliotheque des Sciences, 1760; "Mr "Lyonet has longheld a distinguished place among the great "Naturalists of Europe. His translation of the *Theologie des* "*Insectes*," (this is however a mistake, for Lyonet did not translate the work) "the excellent notes he has added "to it, the magnificent cabinet of shells which he has "constructed with so much taste and judgement, in which he "has spared neither trouble nor expence, and which the cu-"rious come to admire as one of the finest and most compleat "that can be seen,' (now much improved and increased) 'have pro-

"procured him a great reputation, which the new work we "are announcing will confirm; a work which surpasses "the high expectations that were formed of it, and which "will be sufficient of itself to immortalize the author."

2. In the Journal des Scavans, July 1760. "We earnestly exhort Mr Lyonet to publish the Anatomy he "makes us hope for, of the chrysalis and of the phalæna "into which his caterpillar is transformed; and we assure "him before hand of the encouragement and acknowledge-"ments of all those who admire finished works, &c."

Some reputable and learned men have also written in his praise; such as Martinet, Van Gool, H. S. Reimarus, the Rev. J. Lulop, and P. Van Musschenbroeck: which last, in particular, extols Mr Lyonet's observations and discoveries by means of the microscope, above those of Leeuwenhoeck, Reaumur, Baker, Trembley, &c.—After the publication of the Traité Anatomique, Mr Lyonet became, in 1760, member of the Royal Academy of Sciences of Berlin: in 1761, of the Imperial Academy of Naturalists; and in 1762, of the Imperial Academy of Sciences at St. Petersburg.—In order to enable such as might be desirous of following him in his intricate and most astonishing discoveries, respecting the structure of this animal, Mr Lyonet published, in the "Transactions of the Dutch Society of Sciences at "Haerlem," a description and a plate (as he also afterwards did in French, at the beginning of his "Traité Anatomi-"que,") of the instruments and tools he had invented for the purpose of dissection, and likewise of the method he used to ascertain the degree of strength of his magnifying glasses. Notwithstanding all this labour, which was considerably increased by the extensive correspondence which he for many years carried on with several learned and respectable personages, he still found means to set apart a large proportion of his time (as he himself mentions in his preface) for the immediate service of his country; but was not fortunate enough (as appears by his writings) to get any other recom-

pense

penſe for his exertions than ſorrow and diſappointment.—During the laſt fifteen or twenty years of his life, Mr Lyonet added to the valuable treaſure he had already collected of natural curioſities, a moſt ſuperb cabinet of paintings, conſiſting of more than 560 performances; among which are many of the moſt eminent works of the firſt Dutch maſters. He did this with a view to procure himſelf ſome amuſement during the latter part of his life, when old age and infirmities muſt weaken his powers and ſet bounds to his activity. He had always indeed accuſtomed himſelf to employment; inſomuch that he has written ſome pieces of Dutch poetry; and this diſpoſition remained with him, till within a fortnight of his death, when he was attacked with an inflammation in his breaſt, which, though apparently cured, was, in the end, the cauſe of his diſſolution. He was a friend to all thoſe who loved or exerciſed arts or ſciences. His conduct, from his youth, was ever, and in every reſpect, unimpeachable. He was from conviction a Chriſtian, loved virtue, religion, and his country, and never feared openly to defend them. Nor was it ever in the power of man to make him diſſemble; for his great and favourite maxim was, never to do any thing deſignedly which might hurt either conſcience, duty, or honour. Letters, arts, ſciences, (and particularly natural hiſtory) true religion, and his country, were indebted to him, and ſuffered a conſiderable loſs by his death. Mr Lyonet bequeathed the remaining copies of his " Traité Anatomique,' together with all the plates deſigned and engraved by himſelf, to his nephew, Mr S. E. Croyſet, ſecretary to the poſt-offices of Holland, and who has ſucceeded him in the poſt of ſecretary of the cyphers. He alſo left him a work, ſtill in manuſcript, which he had hoped to bring to light, intitled, " Œuvres Melées " ſur les Inſectes," compriſing all the remarkable reſearches and diſcoveries which he had, during many years, made on the inſects which are found in the environs of the Hague, together with their different forms, changes, &c. and to which

which is added, an "Essai Anatomique sur la Chrysalide et "la Phalene de la Chenille qui ronge le Bois de Saule.' Each of these works Mr Lyonet had originally intended to accomplish upon the same plan as the "Traité Anatomique;" but, unfortunately, a dimness in his sight obliged him, at about the age of 60, to lay aside this design. The "Essai Anatomique," was, however, already finished; and both performances, arranged so as to form a second volume to the "Traité Anatomique," are in fair MS. and enriched with fifty-four plates, all designed by himself, and of which a great number have already been engraved under his own eyes. And Mr Croyset, who has been in the habit of thirty-six years intimate friendship with his relation Mr Lyonet, who has daily seen him at his occupations, and of course is well acquainted with his methods of drawing, and who in his younger days has himself successfully practised that amusement, has determined to use his best endeavours to get such plates as are wanting executed in a masterly style, and to publish these two works, which will prove an important acquisition to the lovers of natural history. He died at the Hague, January the 10th, 1789; in the eighty-third year of his age."

The history of the Notes to Lesser's work, is thus given, by Mr Lyonet himself, in an advertisement prefixed to the French edition.

"The success which this book had in Germany, and the encomiums bestowed on it in the Leipsic Transactions, induced the publisher to have it translated into French. He requested me to revise the manuscript, and to correct those passages which the translator's ignorance of the subject might have occasioned. That I might not deprive the public of the advantage to be derived from a book, intended to promote the glory of God, I undertook the task; but I had no sooner begun than I found that the faults of the translator were not the only ones I had to correct, but that the original

original itſelf in many places ſtood in need of reviſion and elucidation. Mr Leſſer, though very learned in natural hiſtory, had allowed himſelf to believe too many things on the credit of others. The eſtimation in which I hold this ſtudy, which is only delightful in ſo far as it is true, made me view this defect with concern in a work which, from its general excellence, might have contributed to perpetuate error; and I reſolved to correct thoſe paſſages in which the author, miſled by authority, had been miſtaken. To do this, the ſimpleſt and ſhorteſt way would have been to alter the text; but I could not allow myſelf to make an author ſpeak contrary to his own ſentiments, and therefore had recourſe to Notes. But I have gone farther than I at firſt intended. I had no ſooner begun to conſider the text, than ſeveral facts partly known and partly new, connected with the ſubject, occurred to me; and as they appeared calculated for confirming, explaining, amplifying or limiting what the author expreſſes in general terms, I have detailed them, and added various reflections which I hope will not be uſeleſs to thoſe who mean thoroughly to inveſtigate the ſubject. I ſhall perhaps receive the thanks of intelligent men for having endeavoured to produce exceptions to the moſt general rules; for beſides that thoſe ſingularities, which nature ſometimes preſents us with when we leaſt expect them, help us to acquire a more perfect knowledge of inſects, they are what in natural hiſtory may be called the truly marvellous, which it is now time to ſubſtitute in the place of what has been falſely ſo called, and which has too long prevailed on this ſubject. The Reader I hope will give me credit for what I advance; and I ſtand the more in need of his indulgence as I have related certain facts which I would myſelf have unwillingly believed had not poſitive experiments convinced me of their truth."

THAT this work has not till now appeared in Engliſh is owing probably to the following reaſons. When it was firſt pub-

published the ſtudy of inſects was little cultivated in Britain; the ſyſtem of Linnaeus, which reduced the chaos into order, was not yet perfected, and our language had not yet formed and adopted a number of words and terms which it was neceſſary ſhould be current before a translation could be attempted. Even at this day the want of terms is probably the reaſon why the excellent publications of Reaumur, De Geer, and many others, are ſtill only known in this country in their original language. In this reſpect the translator of the work now ſubmitted to the Public, muſt likewiſe throw himſelf on the indulgence of the Reader. For many terms he has been obliged to make uſe either of the Latin or the French word; but he hopes never except when theſe words are perfectly well underſtood, and have become, through uſe, inoffenſive to the Engliſh ear. But what no doubt chiefly tended to obſtruct the translation of the book into Engliſh was, the difficulty of aſcertaining the identical inſects which the authors mention by local names without ſufficient deſcriptions. It is not a mere knowledge of the languages in which the book was originally written, nor a mere acquaintance with the ſubject, that can enable a translator to overcome this difficulty. He muſt have an opportunity of conſulting a variety of books, ſeldom to be met with in private libraries, and ſome of them rare even in the beſt public collections in this kingdom. The chief value of the preſent performance to naturaliſts will therefore conſiſt in its identifying the greater part of the inſects by the Linnean name, an advantage which they well know how to appretiate.

It muſt be mentioned that as the original work was publiſhed before the accurate definition of an inſect was given by Linnæus, the word is uſed much more looſely than at preſent. By Leſſer all the animals that compoſe Linnæus's claſs of Vermes are called inſects; and even Lyonet, who defines an inſect to be an animal with an external ſkeleton, gives the ſame name to ſnails. The Naturaliſt, accuſtomed to

the ſtrict acceptation of the term will revolt at this inaccuracy; but it was thought better to retain the expreſſion, than to ſacrifice the obſervations and reflections it ſerves to introduce.

It was ſuggeſted to the translator, that by uſing the information contained in the following pages, along with the materials afforded by modern diſcoveries, an altogether new work might be conſtructed, with more unity in the plan and more preciſion in the execution. But not to mention that ſuch a proceeding would have implied an intention to rob the original authors of their juſt fame, he thought that it would be agreeable to many readers to ſee their different ſentiments on the ſame ſubjects, and that the work would ſtill be intereſting in its preſent form, as marking an æra in the history of the knowledge of inſects.

As the claſſical works of Ray and Derham on Phyſico-Theology are known and admired by all; this performance, being an enlarged diſcuſſion of a topic which they touch upon but slightly, ſeemed to have ſome chance of a favourable reception with the public. Thoſe who have been deterred from the ſtudy of inſects by the idea that they are a loathſome and noxious part of the works of creation, will here, it is hoped, find arguments to convince them of their miſtake. The principal propoſition maintained by the author will likewiſe, no doubt, with ſome have its effect; for whatever weight may be thought due to the reaſoning of Leſſer, by the philoſophers of the preſent day, the ſincerely pious will give him credit for his intention, and may profit by his zeal.

The Notes are placed by themſelves, with proper references, at the end of the book, that they might not crowd the pages, nor tend to interrupt the reader in following the train of thought purſued by the author.

Thoſe

Thoſe Notes to which an Aſteriſk is prefixed are by the Author, and a few of them which it was not thought neceſſary to particularize, by the Tranſlator.

In this age of refinement and faſtidious criticiſm, when all performances ſubmitted to the public eye are expected to be finiſhed in the higheſt degree, the ſtyle of this tranſlation, we fear, will hardly ſtand the teſt; but if it wants the energy and ſpirit of the original, it is hoped it will not be found deficient in faithfulneſs and perſpicuity.

CONTENTS.

CHAP. PAGE.

BOOK

BOOK II.

PART I.

BOOK II.

PART II.

BOOK II.

PART III.

VII. Of

INTRODUCTION.

There is nothing in Nature, however abject it may appear, which is not a ſubject of wonder to the man who ſets himſelf ſeriouſly to conſider it. Far from being unworthy of our regard, the ſtudy of Nature is not only uſeful but neceſſary to us, ſince it furniſhes as many occaſions of praiſing our Creator, as there are objects to contemplate. But the greater part of mankind, inſenſible to this reflection, hardly deign to caſt their eyes on thoſe objects which they have thought proper to denominate vile. Inſects they conſider as below their notice, or merely as ſubjects of curioſity, which it would be both uſeleſs and troubleſome to inveſtigate; and to this contempt, we muſt attribute that indifference with which moſt people are accuſtomed to examine them. They are viewed without regard, and inconſiderately cruſhed to death, when they are found in our way.

I could excuſe a vulgar mind for ridiculing the ſtudy I recommend: but I think myſelf authoriſed to raiſe my voice againſt men of learning, who would rank the ſtudy of inſects in the number of human weakneſſes. Is not the ſmalleſt worm, the work of the Supreme Being, as well as the moſt perfect animal? And if God has judged it not below him to create

it, why ſhould it be thought a weakneſs in a reaſonable man to make it the object of his reſearch? But the vileſt inſect is a work of omnipotence, worthy of the higheſt admiration. It is endowed with ſo many perfections, that the moſt powerful monarch, or the moſt ſkilful artiſt, can produce nothing to be compared with it. God alone can work thoſe wonders, and he preſents them to us, not as models for our imitation, but as ſo many teſtimonies of his power and wiſdom. It is our duty therefore to correſpond to his views, and to contemplate his perfections, even in the ſmalleſt of his works. Among all the animals, we alone, are capable of this contemplation. The ſun ſheds his beams over all the earth; but man alone comprehends their ſource and perceives their effects. Beaſts live and grow, but they know not how. The Lion is unconſcious of his ſtrength; the nightingale of the melody of her voice; the butterfly of the beauty of its wing; and the caterpillar gnaws the leaf without knowing what it is that affords it ſuſtenance! Can we doubt then, that the tribute of admiration which I demand from the faculties of man, is a reaſonable tribute, which he owes to his Creator?

Man ought not to confine his reflections to inſects alone, he is capable of carrying them infinitely farther. I allow it; I even confeſs that he would in ſome degree debaſe his powers, were he to limit himſelf to this ſingle employment; and were he, for the ſtudy of inſects, to ſacrifice the knowledge he

he may obtain of the ſtars, of plants and of ſo many different animals. My deſign is not to be the apologiſt of thoſe who are mere collectors of the refuſe of Nature, if I may uſe the expreſſion; and who make cabinets for ſhew. There are things more worthy of their attention. But on the other hand, I cannot blame the man of piety, who contemplates the power of his Creator in the ſmalleſt as well as in the greateſt of his works. It is true, he cannot become acquainted with the whole. The objects which the heavens, the earth, and the waters preſent to his meditation, are too manifold for him to hope that he can know them all alike. Such an attempt is far beyond the powers of man. Every one ought therefore to chuſe, amongſt the infinite variety of the works of God, ſome particular department as the principal object of his ſtudy. Convinced of the juſtice of this reflection, I have betaken myſelf to inſects; I have ſtudied them with all the application I am maſter of, and I have found them more entitled to admiration, than to contempt. The remarks I have made on the ſubject appeared to me of ſufficient importance to be laid before the public. They will ſerve as a proof, that the majeſty of the Creator is manifeſt in all his works, and that it ſhines conſpicuouſly even in the ſmalleſt inſect.

But I am not the firſt who have painted them out as exhibiting viſible marks of the omnipotence and infinite wiſdom of the Being, who preſides over the Univerſe. " Every ſpecies of animals,

' (ſays

'(says St Augustin,) is possessed of beauties peculiar to itself. The more man considers them, the more they excite his admiration, and the more they engage him to adore the Author of Nature, who has made every thing in wisdom, who has subjected every thing to his power, and whose goodness governs the whole. These attributes are discoverable in the very vilest of animals, which are destined by their nature to perish, and whose dissolution terrifies us. They are small, it is true, but the delicacy and arrangement of their parts is admirable. If we examine with attention a common fly, its agility will appear more surprising, than the swiftness of a beast of prey at full speed; and with the same attention, the strength of the camel will seem less wonderful than the labour of an ant."

'If you talk of a stone, says St Basil, of a gnat or of a bee, your discourse is a sort of demonstration of the power of him who formed them; for the wisdom of the workman generally manifests itself in what is most minute. He who hath stretched out the heavens, and who hath hollowed the bed of the ocean, is the same who hath pierced the sting of the bee, to form a passage for its poison.'

St Jerome is equally clear: 'It is not only in the creation of the heavens, of the earth, of the Sun, and the sea, of elephants, camels, horses and oxen, of tigers, bears, and lions, that the Creator is to be admired. He is not less

'great

'great in the production of the smallest animals, 'such as ants, flies, gnats, and other insects, which we 'know better by sight than by name. The same 'power and the same wisdom are remarkable in all.'

'It is without reason, says Tertullian, that you 'despise those animals, whose minuteness the great 'workman of Nature has recompenced by endow- 'ing them with industry and strength. By this he 'has shewn that greatness may be found in the smal- 'lest things, as well as strength in weakness, to use 'the words of an apostle. Imitate, if you can, 'the structures of the bee, the granaries of the ant, 'the webs of the spider, and the threads of the silk 'worm! Put your patience to the proof, by en- 'deavouring to support the insults of those ani- 'mals which attack you even in your beds, the 'poison of the cantharides, the sting of the wasp, 'and the proboscis of the gnat! What might not 'larger animals do, when such as these can ei- 'ther serve or injure you! Learn then to respect 'the Creator, even in those works that appear to 'you the most vile.'

The enlightened among the heathen thought in the same way with the fathers of the church. 'It does not become a reasonable man, says Aristotle, 'capriciously to blame the study of insects, nor to 'take a distaste at it from the trouble it occasions. 'Nothing in nature is mean; every thing is sub- 'lime, every thing worthy of admiration.'

Pliny

Pliny expreffes himfelf on the fame fubject in terms ftill ftronger, and what he fays deferves particular attention. 'It is eafy, fays he, to conceive
'how Nature has given to bulky bodies the qualities
'we fee them poffefs. Enough of matter enters into
'the mafs, to contribute without difficulty to the
'formation of the various faculties with which fhe
'has endowed them; but it is otherwife with thofe
'which by their fmallnefs feem to be almoft nothing.
'It is in them we difcover the perfection of wifdom
'and of power. How could fpace enough be found
'in the body of a gnat, not to fpeak of other animals
'ftill more minute, for thofe organs, that are the
'inftruments of fo many different fenfations? Where
'could Nature find room for the organs of fight;
'where for thofe of tafte and fmell? Where could
'fhe find matter for the organ of found, fo
'fhrill and fo acute in that little animal? With
'what art has fhe not fupplied the wings and the
'members, formed a ftomach and inteftines greedy
'of blood, efpecially of the blood of man? With
'what induftry has fhe not provided the means of
'fatisfying its appetite? She has furnifhed it with
'a weapon, and as if this inftrument, though al-
'moft imperceptible, was capable of variety of
'forms, fhe has beftowed on it a fharp point,
'and has hollowed it, that it might ferve as an
'inftrument for piercing, and a pump for fucking
'at the fame time. What teeth has fhe not given
'to the Teredo? Of this we may judge by the noife
'it makes when grinding the wood, it has deftined
'for food. The fize of the elephant aftonifhes us;
we

'we view with admiration towers built on the back 'of that animal; we are surprised at the strength in 'the neck of an ox, and at the weight he can raise 'with his horns; the voracity of tigers amazes us, 'and we wonder at the mane of the lion. But it is 'not in these instances that Nature appears most 'admirable. Her wisdom is no where more con-'spicuous than in her smallest works. There she 'unites herself as it were into a single point, and 'there she concentrates herself wholly. I beg there-'fore of such of my readers who despise those 'things, not to disdain the account I give of them; 'let them remember, that in nature there is nothing 'inconsiderable, nothing superfluous.'

What would one think of an artist who should be able to reduce all the wheels and movements of a watch into so small compass, that the whole might be set in a ring like a diamond? One would admire it without doubt: and indeed such a masterpiece would be worthy of admiration and would be prized far above a watch of the common size. The same thing may be said of animals. The power and wisdom of the Creator seem particularly conspicuous in the formation of the most minute. Can we, then, justly neglect such a call upon our worship and adoration! However small these creatures are, even those which are with difficulty discovered by the aid of the microscope, they have all the parts that are necessary for them; they have all articulations, muscles, and nerves; and all are covered with a skin suited to their condition.

Galen supports with much found sense the reasoning I here use, and perfectly justifies the conclusion. That great man says, that the smaller things are, the greater is their value, and that workman is the most to be prized, who can make in small compass what others cannot make but in large. He relates to this purpose, the instance of a sculptor of his time who represented, on a ring, the figure of Phaeton in a chariot drawn by four horses. The work was executed with so much delicacy, that the very reins of the horses were to be seen, and although their limbs were not larger than those of a flea, the teeth in their mouths were visible. From this Galen takes occasion to remark the infinite distance between the power of the creature, and that of the Creator, between the wisdom of the Being who formed the flea, and the skill of the sculptor, who had represented horses so very minute.

I know that the study I am to treat of is subject to many inconveniences. Insects are not always to be found, many appear only at a particular time of the year, and that is so short, that they are often gone before we are aware. Some escape us by the velocity of their flight; others shew themselves only at night, and oblige us to watch for them at that season. Some live in places which are of difficult access or which we cannot at all reach: others make their abode in substances which we see but seldom. One may be within our power, but its volume is so diminutive, that the best microscope cannot discover all its parts; or its poisonous

ous nature will not allow us to become familiar with it. Besides, with what difficulty do we attempt to explore the interior structure of their bodies? The instruments which anatomy has invented for dissection become useless when we prepare to enter into a detail of the minute parts of the greater animals. How then is it possible to observe with precision, the viscera, the veins, the arteries, the fibres, and muscles of creatures so small, and so delicate as insects? But these difficulties, however great they may appear, ought not to discourage the Naturalist, nor prevail over the reasons that should urge him to prosecute his researches. Those I have already mentioned, deserve his attention; those I shall enumerate in the sequel, are not less important; and I flatter myself, that if, free from prejudice, he will deign to weigh them maturely, he will not condemn my attempt. Far from classing me with that Emperor who spent his life in catching flies, he will allow that the study of insects, in which I have engaged, is not unworthy my character as a Clergyman.

It will easily be imagined that I must have had considerable assistances to enable me to prosecute this study, which has for its object, the greatness and majesty of the Divine Being. It was necessary in the first place to consult the sacred Scriptures, and in the next, to penetrate into the bosom of Nature, to discover in that treasure those marks of goodness, of wisdom and power which his hand has there so richly lavished. It is true, that in this last part of my work, I have trode in the steps of many wise and illustrious men, and I

have been able to take advantage of their discoveries; but I have not entirely relied upon them. I considered myself as obliged to study the structure of the bodies of the larger animals; and I descended to the contemplation of those whose minuteness requires the aid of instruments. The greater progress one makes in this world of wonders, the more grandeur one discovers in it, and the more we are convinced that it is an ocean of which we see only the shores. An astronomer has no doubt great difficulty in surveying the vast extent of the heavenly bodies, but it is not less difficult to consider the almost infinite diversity of insects spread through the air, over the earth and in the waters. If the telescope of an astronomer allows him to discover a thousand things, wonderful from their bulk, or their revolutions, the microscope enables the observer to discover in insects as many things marvellous for their minuteness and the changes they undergo.

Many curious men have dedicated their leisure hours to the collection of all the different sorts of insects that have come to their knowledge. It must be allowed that such collections are of great use, they present at one view a great many objects of curiosity, unknown to the generality of people, who are inchanted with the sight of so many rarities collected together, which they often had seen separately, without bestowing on them the smallest attention. In this manner one is often enabled to instruct some, and to satisfy the curiosity of others. Besides, it is always safer to consult the originals, than to trust to their reprenta-

tions,

tions, by the pen or pencil. These always express with fidelity, and without disguise, every object as it is formed by Nature; but the latter may easily lead to error.

Not that I disapprove of the labours of those who have undertaken to delineate objects from life; far from it. I admire a book in the library of the Vatican at Rome, the margins of which are adorned with a great number of figures of insects exceedingly natural and correct. Mr Franck of Ulm in his old age, painted a whole book of excellent figures. When I consider the exquisite nature of the work, which the illustrious Marie Sibylle Merian has published on the Metamorphoses of Caterpillars, and on the flowers of the plants which furnish their principal food, I cannot enough admire the accuracy with which she delineates those insects in their different states; and her talent of presenting to the eye, the variety which nature has established in the mixture and distribution of her colours. She has not confined her labours to the insects of her own country; her zeal carried her to undertake a voyage to the West Indies; which procured for us in 1705, another work on the transformations of the insects of Surinam. Similar representations have not a little contributed to the reputation which J. Hoeffnagel, first painter to the Emperor Rodolph II. has acquired. The edition which was printed by J. N. Visscher in 1630, containing 326 figures, established his reputation. It was by designs of insects that the cabinet of Arundel was enriched, and by

which the industrious Winceslas Hollaar, acquired the admiration of the public. J. Johnston did not think he misemployed his pencil in painting a great number of butterflies, which Monconys says he saw at Basil in the hands of Mr Platern. I have myself seen at Furra, in the house of M. de Wurm, Gentleman of the Bed chamber to his Polish Majesty, some butterflies painted in miniature by that gentleman on blue paper, with great art and accuracy. These drawings have not only the advantage of recalling the idea of every sort of known insect, but present a sort of abridgement of the works of nature in this particular. On looking at them, we behold at one view the insects of all seasons, and of every country. Besides, they supply the deficiences of the pen in description; and they exhibit all the beauty of their originals.

To continue to do justice to those persons, whose knowledge has assisted me in the composition of this work, I ought to mention those authors who have examined the different parts of insects with the microscope. The first that I find, is J. Bononius, who in 1687, published a letter at Florence, in which he enters into a detail of several discoveries equally useful and important on this subject. P. Borrelli, Counsellor and Physician to his most Christian Majesty, also turned his attention to the same subject, and has made observations on about an hundred insects of different species. We owe likewise a great deal to J. F. Griendel of Ach, Canon of the Order of the Holy Ghost, and Engineer to his Imperial Majesty.

jesty. R. Hook has however left this last far behind him, for the patience and accuracy with which he has undertaken and compleated his researches. M. Joblot, Professor of Mathematics at Paris, and a Member of the Royal Academy of Sciences, need not regret his valuable labours. He made use of a variety of Microscopes for his observations, and he had one among the rest, which magnified objects, five and twenty thousand times their natural size. I must not forget N. Hartsoecker, Counsellor to the Elector Palatine, and an able mathematician. He was the first who examined the liquid substance in the body of insects; and made use of microscopes for this purpose, similar to those made at Paris for observing fluids. A. Leeuwenhoeck, has acquired deserved fame for his dexterity in observing insects by the microscope, and for the exactness with which he has communicated his observations to the Public. J. de Muralte has equally enriched the Republic of Letters, with his remarks on this subject. I shall say nothing of those of H. Power, printed at London in 1665. I know not whether any thing material concerning insects is to be found in that work. Many authors have confined their observations to a few particular species. Such are F. Redi, who has given us observations on the lice of Birds, and other animals; and P. P. Sangallo, who has likewise written on gnats. Some have treated only of one part of an insect; the Abbé Catalan, for example, has observed the eyes; and Ph. Bonanni, the wings.

All

All the diſcoveries of thoſe authors being due to the Microſcope, it is eaſy to infer how valuable the aſſiſtance of that inſtrument is to the obſerver. It enables us to penetrate into a ſort of inviſible region, and diſplays to our eyes a new world, compoſed of an infinite number of living beings. The antients, deprived of this invention, truſted only to their eyes, which might miſlead them, but could not enlarge their diſcoveries. But by the aid of this inſtrument we have gone a great way; we have paſſed from doubt to certainty, and modern Naturaliſts are enabled to rectify their errors, by the aſſiſtance of thoſe very means which produced them.

It remains for me to ſpeak of thoſe Naturaliſts whom a noble ardour has encouraged to write the Hiſtory of Inſects. Not content with having given us the figure and deſcribed the form, they have detailed their properties. Elian, in his hiſtory of animals, Ariſtotle, and Pliny, in their Natural Hiſtory enter into very intereſting diſcuſſions; but their facility in adopting the ſentiments of others has made them fall into miſtakes, which very much diſcredit their opinions.

The moderns have gone much farther. An Engliſh painter, named Albin, publiſhed in 1720, the Natural Hiſtory of the inſects of his country, which he accompanied with an hundred copperplates, of maſterly execution. It was not in the power of every one to procure ſo magnificent a Work. It coſt two guineas, and the coloured copies four. The

deſcriptions

descriptions are faulty in being too short, but there are several caterpillars represented, which are not be found in any other work. For this reason I prefer it to the rest, and I think it better deserves the Title of the Theatre of Caterpillars, than the work which Blancard has published under that name.

The Treatise which Ulysses Aldrovandus, Professor of Medecine in the University of Bologna, composed, in Latin, on the nature of insects, deserves to be mentioned. If we believe Peter Castell; the study of insects had such charms for him, that he expended large sums in travelling for information; and that during thirty years, he gave annually two hundred florins to a Painter, solely occupied in painting insects for him. The same author adds, that Aldrovandus so much fatigued his sight in making his researches, that he was unfortunate enough to lose it in his old age. The Treatise of this able naturalist on insects, is adorned with several plates, which though executed on wood, are very elegant, and expressive. As to the merit of the work upon the whole, it is a mixture of good and bad. Aldrovandus allowed himself to adopt the opinion that insects were generated from corruption; and he often wanders from his subject for the sake of mere philological discussion. We are indebted to him however, for many excellent observations, which are so much the more valuable, as they come from a man of credit and integrity.

I

I return to Blancard. This Dutch phyfician, after having made a large collection of infects, compofed his *Theatre* from what experience had taught him. In his work we find excellent figures, the greater part of them reprefenting the infects peculiar to his native country. He concludes his Treatife with inftructions for catching and preparing thefe little animals.

C. Gefner profeffor of Medecine at Zurich has alfo given us a Natural Hiftory, in which he treats of the nature of ferpents, and particularly of fcorpions. In common with Aldrovandus, this author was at the expence of travelling, and maintaining a correfpondence with different countries; and the plates of his work are likewife engraven on wood. I confefs that they do not reprefent their originals with perfect accuracy; his induftry, however, has obtained him the name of the German Pliny.

I. L. Frifch, Rector of the Royal Academy, of Berlin, has given a very extenfive defcription of the infects of Germany, without however being liable to the charge of prolixity. In order to eftimate its value fully, we have only to reflect on what it coft the author. He ftudied the myfteries of nature; he employed the microfcope in exploring the objects he defcribes; defigned each part with his own hand, and made them be engraven under his own eye by his fon. The habit of infects, their forms, their members, their articulations, their fituations, the nerves of the wings are all expreffed with accuracy,

accuracy, ſo that perhaps no book was ever more worthy of credit.

J. Goedart, a Flemiſh painter, took a pleaſure, during twenty years in feeding various inſects, in obſerving their changes, and in imitating, with the pencil, the beauty of thoſe butterflies and moths which were moſt remarkable for their colours. His book was firſt publiſhed in Dutch; but that edition being ſoon ſold off, Mr de Mey, Doctor of Medecine, and Miniſter at Middleburg, tranſlated the firſt volume into Latin, and publiſhed it in 1662. The ſecond appeared alſo in the ſame language, tranſlated by M. P. Veezaerd Miniſter in Zealand, who added ſeveral remarks of his own. There was ſtill a third, which the Tranſlator of the firſt undertook, and ſupplied its deficiencies by a great number of notes. Arrangement was ſtill wanting to this work. Dr Liſter, member of the Royal Society of London, took upon himſelf this trouble, but intruſted the publication to one of his friends.

J. Johnſton, Doctor in Medicine likewiſe publiſhed a Treatiſe on the ſame ſubject divided into three parts. It contains little of his own; the figures, which are by no means correct, are inferior to thoſe of Aldrovandus. The work is a mere compilation of what is to be found on the ſubject in that author, and in Mouffet.

This laſt publiſhed at firſt a collection, intituled Theatre of Inſects, &c. begun by Wotton, Penn,

 and

and Gesner. He afterwards gave it in a form of more regularity; he augmented, corrected and illustrated the text, by adding near five hundred figures, which are far from being amiss. This learned Englishman certainly threw a deal of light on the History of Insects; but being prejudiced in favour of Aristotle, he has adopted some errors which that great man had fallen into.

We observe in the History of Insects published by Ray, the Work of a great naturalist. He enters into a detail of the different species of these animals; he indicates their native place, and informs us of their qualities, general and particular.

I come now to the Memoirs of M. de Reaumur, Member of the Royal Academy of Sciences. He published them in 1735, and accompanied them with excellent figures. The following year they were reprinted in Holland, an edition which was afforded much cheaper than that of Paris. This proceeding gave offence to the author, and determined him not to publish the remainder, till the whole work was compleat. The Journalists of Hamburg, allow that it is a master-piece of erudition, of accuracy, of elegance, and of entertaining investigation. They add that it is calculated to convince men of the infinite power and wisdom of the Creator, by exhibiting to them, the lively characters he has impressed upon animals, for which they entertain a profound contempt. This history is not merely entertaining, it is really useful. If we consider it in

in this point of view, it will give no less pleasure to those who read for instruction, than to those who read only for amusement. It is known, and is but too true, that an infinity of small animals desolate our plants, our trees, and our fruits; that they attack our furniture and our cloaths; that they eat the corn in our granaries, and that they do not even respect ourselves: would it not be desirable if we could defend ourselves from such enemies? This M. de Reaumur conceives to be practicable by a diligent attention to the nature of each species. By this means we might be able to destroy them, and their eggs, we might prevent thom from injuring us, and we might render important services to the community by discovering the means of preserving the fruits of the earth, and securing the health of the human body.

There remains a work of G. Rondeletius, Doctor of Medecine at Montpellier, in which the principal design of the author was to treat of fishes, and other aquatic animals. He has not confined himself however closely to his subject, but has treated of insects, and has added figures to his descriptions. In the library of the Jesuits at Ratisbon, there is a copy of this work in two volumes, on the margins of the leaves are large notes, said to be in the hand writing of Gesner. However that may be, this work which must have occasioned great labour to the author is very embarrassing to the reader, for he is not fixed in his principles, but often contradicts himself.

The work of Ruysch, Professor of Anatomy and Botany at Amsterdam is well known. This illustrious author intended chiefly to treat of quadrupeds, of fishes, and birds, foreign and domestic. He has however in the course of his general detail given us the description of a few insects illustrated with figures. This addition is not the least valuable part of his work.

The general history of insects which Swammerdam published in 1669 deserves to fix our attention for a moment. This work, which was printed at Utrecht, seems to have no other fault, but that of being written in a language not generally known. This occasioned its being translated from Dutch into French. The translation was printed in 1685, at the same place in 4to, the size of the original publication. H. Ch. Henninius translated it also into Latin. To render the author's descriptions more intelligible, he added plates representing the four different changes which insects undergo; first in their natural size, and then as they appear in the Microscope. This second translation was reprinted at Utrecht in 1693, augmented with a dissertation, in order to shew the analogy of insects, with other animals and with plants. It cannot be denied that Swammerdam has excelled all those who had gone over the same course before him. He himself went in pursuit of insects into the woods and fields; he collected their eggs, brought out the young, and fed them with all imaginable care. He was seen observing them from morning to night, and at every moment

ment redoubling his attention to them, lest their smallest change should escape his curiosity. An intimate acquaintance with the external conformation of insects appeared to him a very superficial attainment; he employed anatomical instruments for the dissection of these minute animals, and penetrated into the very convolutions of their viscera. He employed a painter three times a week, to paint under his eye, the objects that nature presented him with. He likewise preserved in a cabinet all those insects, their external and internal parts, their eggs, their webs and their nests. Such apparatus, so many experiments, such labour and penetration could not fail of producing an excellent work. The public could not reasonably have exacted more from him than this General History, but he did not mean to stop here: death surprised him at a time when he was employed in composing a history of each particular species. Mr Thevenot, his friend, inherited his papers; but the many occupations of this gentleman prevented him from being able to lay them before the public. From him, the manuscript passed into the hands of J. du Verney an able anatomist, who enriched his own cabinet with it. There it lay buried till there could be found a man as zealous for the advancement of Science as the illustrious Boerhaave. He purchased the work, and was no sooner in possession of it than he hasted to communicate this treasure to the world, and put it to the press in the year 1736. He joined with it the other history of the author: the work is full of excellent figures and he called it *Biblia Naturæ sive historia Insectorum.* The first part contains the gene-

ral

ral history of infects with additions and corrections; and the second the history of each of them in particular. We find in this second part the natural history of gnats, of bees, of the maggots in cheese, of moths, of the gad-fly, of the caterpillars that lodge within the leaves of the oak, willow, &c; we find also that of the frog; of the Ephemeræ, insects which are produced and die the same day; of the flea, and water-scorpion. Besides these, the author has given the anatomy of the Sepia, and that of the louse, and the description of the Lucanus Cervus, or flying stag. There are also four particular treatises; one of them on the insects which grow in the galls of Plants; the other on the seed of the Fern; another shews how the butterfly is formed under the skin of the caterpillar; and a fourth on the sea animal called Physalus. The whole work is full of curious observations which besides entertainment furnish much information.

The learned have likewise profited greatly by the treatise of the celebrated Valisnieri. His book contains a great number of curious and interesting observations.

Such are the assistances afforded us in the study of insects. They are no doubt considerable, and guided by the works of the learned men I have just named, we cannot fail of making very great progress. I cannot however but regret the loss of the works which a great King composed on the natural history of plants and animals. What light would they not throw

throw on the ſubject I am treating of, conſidered as the productions of a Prince, 'who was wiſer than 'all men, and who ſpake of trees, from the Cedar 'tree that is in Lebanon, even unto the hyſop that 'ſpringeth out of the wall: he ſpake alſo of beaſts 'and of fowl, and of creeping things, and of fiſhes.'

But why deplore a loſs which Heaven has thought fit we ſhould ſuſtain? Let us put an end to our regrets, and repair that loſs by a continual ſtudy of the works of thoſe great men whom I have juſt named.

But we muſt not confine ourſelves even to this. However numerous the obſervations of theſe celebrated Naturaliſts may be, they are far from having exhauſted the ſubject; they have left to poſterity a large field for diſcovery. Thoſe Inſects that are beſt known are not perfectly known: the more one ſtudies them, the more one is convinced of this truth, and if we can add any thing to the labours of thoſe who have gone before us, in thoſe very places where they have been moſt ſucceſsful, what may we not do in thoſe where they have failed? Beſides, as we are not acquainted with all the different ſpecies of inſects, thoſe which remain to be diſcovered furniſh an ample field for exerciſing the induſtry and ſagacity of the curious. The ſubject is inexhauſtible, every day furniſhes us with ſomething new; and he who thinks he has made great proficiency, will receive information from one who has not made ſo much as himſelf. We have

have the ſame opportunities of improvement, and the ſame aſſiſtances with our predeceſſors; why do we not make uſe of them? The microſcope which has diſcovered to them ſo many wonders, till then un-unknown, has equal wonders in ſtore for us. That inſtrument withdraws the veil, which conceals nature from our eyes, and makes, if we may uſe the expreſſion, an elephant of a fly, by exhibiting it to us ſixteen millions of times larger than it really is.

Theſe reflections on the diſcoveries that ſtill remain to be made in the world of inſects are the fruit of my experience. For many years I have applied myſelf to this ſtudy. I have obſerved thoſe minute animals ſometimes with the aſſiſtance of nature alone, and ſometimes with the aids which art had procured me; but I was always convinced that the ſubject was not exhauſted. In this belief I do not heſitate to preſent this work to the public, notwithſtanding ſo many others have preceded it. Among the great number of new remarks I have made there may be ſome that will not be diſpleaſing to my readers.

This work will therefore be compoſed of my own obſervations, and of thoſe of others, which mutually ſupport each other. When mine do not appear ſufficient, I ſhall call thoſe of others to my aid. In this caſe I ſhall endeavour to borrow with diſcretion and fidelity. For this end I ſhall follow the authors who are moſt exact, and moſt to be depended on; and I ſhall mention to whom I am indebted for my obſervations. As to method, I will not follow that of any author

author whatever. It is well known that ſome, after having diſtinguiſhed inſects into ſeveral claſſes, have divided their work into as many parts as there are different ſpecies. Others have been content to give their obſervations juſt as they occurred without any other arrangment then chance ſuggeſted. I ſhall begin by making an exact and general diviſion of inſects; after which I ſhall treat in detail of their parts and qualities, inſtead of confining myſelf to a mere Natural hiſtory, and I will endeavour to diſpoſe my readers to attribute to God, all thoſe miracles that I ſhall lay before them.

But a compleat hiſtory of inſects, muſt not be expected here; the thing is impoſſible. How is ſuch an amazing number of ſmall animals to be inveſtigated? How many ſwim on the ſurface of the ſea, or lurk at the bottom of the deep that we can form no idea of; who can tell the number of thoſe that ſwarm in the bottom of rivers, in marſhes and ſtagnant waters, and which never appear on the ſurface? How many unknown inſects may there not be in thoſe countries into which no traveller has hitherto entered? So true is the remark of the ſon of Sirach! "The diverſity "of animals, is one of the moſt incredible and won-"derful works of the Creator. However much we "may ſpeak of them, we ſhall never declare them all. "Many things are hidden, greater than thoſe we "know, and we have only ſeen a part of his works."

INSECTO-THEOLOGY:

BOOK I.

CHAP. I.

OF THE CREATION AND GENERATION OF INSECTS.

THERE is nothing in the universe which does not owe its existence to some cause different from the universe itself. To this cause must be attributed the different forms of things, and their existence in one form, rather than in another. This cannot be denied, without obliging us to maintain, that every thing in nature, sprang from nothing. But to what would such an absurd opinion lead? Surely to two contradictions equally palpable. The first, that nothing had produced something at the very time when it was not what it was necessary it should be, in order to its producing; the latter that some one thing had produced itself; which supposes it to have existed before its own formation.

As Insects make a part of those bodies that compose the universe, they are subjected, in common with every other, to this general law. They have a principle of existence distinct from themselves, a principle from which they receive their nature and form, and which retains them constantly in that very form, though it is easy to conceive that they might have had a different one. For in the same way as a painter, who works from fancy, may represent Insects whose possible existence is only imaginary, and animals of uncommon shapes; grasshoppers for instance, like those in the Apocalypse, with the face of a man, the hair of a woman, the teeth of a lion, the tail of a scorpion, or any thing still more incongruous which his imagination can suggest; in the same way might the insects which exist in nature have received from the creative principle a form, different from that they actually have, and which distinguishes them from every other living creature.

Now the question is to know what this principle is, which hath formed insects such as they are; whether it resides originally in themselves, or if it emanates from some extrinsic power. It cannot be said to reside in themselves; in that case they would be the authors and masters of their own existence; they might change their form at pleasure, they could also make themselves immutable and immortal. But far from possessing this independance they are so subjected to the laws of their species, that a flea can never produce a wasp, nor a bee a grasshopper; that the parts they are composed of grow impotent through use, change and perish; and that if by any accident they lose a limb they cannot repair that loss, by giving themselves another.

We are acquainted only with two orders of substances, one material, the other immaterial. The material

ferial ſubſtance, being in the ſame circumſtances with inſects, is not the cauſe of its own exiſtence, and cannot beſtow it on any thing whatever. For the truth of this I appeal to experience. The man of moſt exalted endowments in the claſs of material beings, whatever intelligence and induſtry, he may be poſſeſſed of cannot create the ſmalleſt inſect. But if matter is not the principle which gives theſe exiſtence, can we ſay that they have received it from the ſecond ſort of ſubſtances called immaterial? By no means; for immaterial ſubſtances have only a very limited power, but an infinite power is neceſſary to draw any thing out of nothing; conſequently no created being can be the creative principle of inſects, conſequently likewiſe, in order to find this principle, we muſt aſcend to a ſupreme being who exiſts by his own energy, who cannot ceaſe to exiſt, who is permanent, immutable, and who includes in himſelf the cauſe of all things, in a word to that being whom we know under the name of God.

It is alſo this great Being whom the Scripture points out to us, as the general cauſe of every thing that exiſts. "Lift up your eyes on high, and behold who hath created theſe things, that bringeth out their hoſt by number: he calleth them all by names, by the greatneſs of his might, for that he is ſtrong in power, not one faileth."——"Lord, thou art God, which haſt made heaven and earth, and the ſea, and all that in them is."

Inſects are not excepted from this general law; "God, ſays Moſes, commanded the earth to produce living creatures after their kind, cattle, creeping things, and beaſts after their kind." Is not God then the author of Inſects as well as of other animals?

For

For the manner in which insects have been perpetuated from their creation to this day we can easily account. Like all the other animals they multiply by means of generation. Upon receiving existence they at the same time received the power of producing their like, and of preserving in this manner, their species for ages. The same God who created them by his power, blessed them, and ordered them to encrease, and multiply on the earth, each after its kind. GEN. I. 22.

The antient philosophers were not at all of the opinion of Moses on this point; some believing that the greater part of insects were not multiplied in the ordinary way of generation, but were engendered by all sorts of matter. This they called equivocal generation, and they did not confine this idea to insects alone. Many plants according to them, could grow out of the womb of nature, without being sown or cultivated. It would not be difficult to shew how little solidity there is in either of these opinions; but as the last does not belong to my subject, I shall confine myself solely to demonstrate the falsity of the first.

Observers of nature having remarked swarms of insects in different substances, imagined that those diminutive animals, were produced immediately, without the concourse of any animal of their own species. Such they found in putrid flesh, in the entrails of animals, in the leaves of plants, in rivers, in rain water, in snow and in dust; therefore said they, it is from these substances that they derive their existence. If these philosophers were asked how such a thing could happen; they gravely answered, that the heat of the Sun, augmenting the fermentation of these substances, the insects were produced by the fermentation. People were long satisfied with such reasoning, because no one ever took the trouble of examining

ing the subject more closely. The moderns, better observers than the antients, at last arrived at the truth. They found that insects only grow in such substances, when others of the same species have previously deposited their ova in them; and that the Sun has no further effect in their generation, than that of giving the necessary warmth to these ova. The experiments of Redi alone, an accurate naturalist leave no room to doubt of the fact; they are decisive.

To assure himself that insects are not produced from corruption, he took the flesh of Serpents, of Pigeons, Oxen, Horses, and Fishes; and put these into two crystal vessels, one of which was shut, and the other open. What was the consequence? A short time afterwards, the open vessel swarmed with little maggots, that turned afterwards to flies; while the other did not produce a single insect. But it may be said there would have been no difference in the two vessels, had not the air been intercepted, and consequently the production of the insects prevented. This objection occurred to our naturalist and engaged him to institute a new experiment. He filled a third vessel with a similar mixture, and covered the aperture with gauze, sufficiently tight to exclude all insects, but open enough to allow a free entrance to the air. Undoubtedly the same insects would have been found in this vessel which were observed in that which had been open to the air, if corruption alone could have made them grow. But that did not hapen. The vessel which was covered with gauze did not contain any animals.

The opinion that Insects are generated from plants is not better founded. On this subject we have the decision of the celebrated Malpighi, whose authority will appear respectable to all who know the merits of

of that learned Physician. It is known that maggots and flies, breed in protuberances on trees called Gall-nuts. These insects would appear at first evidently produced by what is called equivocal generation; and so the vulgar believe; but Malpighi discovered that flies deposited their eggs on those trees, that they were the occasion of those tumours, and that from the ova grew maggots which at last produced flies like the parent.

But there is no necessity for adducing more proofs of a fact in favour of which common sense speaks so decidedly. How can we conceive that a substance should produce another of a nature much more excellent than its own? But this would be the case of a plant which should produce insects. If it were true that it could give us such productions, it could not give them, but in one of two ways, either by means of an unapt material, which would approach very nearly to a creation; or by purifying that material, so as to render it fit for the production of an insect; which surpasses its power. The semen of an animal does not arrive at that degree of perfection necessary for the production of another animal, without the assistance of a great number of faculties, of which plants are entirely destitute. What elaborate preparation in the proper vessels! what digestion, what secretion, what circulation, before that matter is sufficiently purified, and has acquired its necessary qualities! Insects which lay eggs have the vessels necessary for their formation; they are endowed with the faculties necessary for their fecundation, and the means of discharging them when they arrive at maturity. Nothing of all this is to be found in Plants. Whatever analogy there may be, in many circumstances, between them and animals a very great difference is observable between their functions, their faculties, the~~re~~ vascular

ir system

ſyſtem, their means of propagation; it can never therefore appear credible that they have the power of generating Inſects, the production of which requires ſo many qualities of which they are deſtitute. I maintain the ſame thing of all other inanimate bodies; and I do not heſitate to ſay that a watch, with all its wheels, might ſooner grow from the filings of ſteel, than an Inſect could be formed by an inanimate body, however perfect the organs of that body might be in its kind.

Intelligent perſons never give into an opinion ſo ill founded as that I am refuting. They eaſily perceive that it is contrary to reaſon, and to the courſe of nature; they even find weapons to combat it in the ſacred Scriptures. Indeed, we may remark that God gave to every creature, the loſs of which would have drawn with it that of the whole ſpecies, the faculty of producing its like, before it ſhould periſh itſelf. He did not leave this office to chance, but willed that every ſpecies ſhould contain in itſelf the germ and ſeed of an animal, or of a plant of the ſame ſpecies, and not of any other. "Let the "earth, ſays the Creator bring forth graſs, the herb "yielding ſeed, and the fruit tree, yielding fruit after "his kind, whoſe ſeed is in itſelf upon the earth." Theſe plants therefore have their ſeed in themſelves and can perpetuate their own ſpecies, but they can produce nothing elſe. It is not otherwiſe with animals. After God had created them, each after its kind, he gave them the faculty of multiplying by generation. Each after its kind had thenceforth the power of producing its like; but this power was confined ſolely to its own ſpecies, and it would be vain to ſuppoſe, that an inſect could produce inſects of a ſpecies different from its own. Gen. 1. 21. 22. 28. Since that time no derangement has taken place, no interruption in the order which God at

first established. Vegetables have continued to preserve and multiply themselves by their seed, and insects by their eggs. Can we doubt then that God included insects in the number of those animals to which he gave his benediction after he had created them? The command to encrease, to multiply and replenish the earth, was given to them no less than to the other species of living creatures. And if it was given to them, must they not be subject to the same laws, and perpetuate themselves in the same manner?

If we attend to the foregoing reasoning we shall be easily persuaded that insects possess all the parts necessary for generation; that there is among them different sexes; that they pair, and that they enjoy all the necessary organs for the formation and preservation of their ova. To these I add another observation, which is, that if Insects were ingendered in the manner contended for by those antient Philosophers, we should every day see new species. The action of the Sun on plants and putrid substances is not so uniform but it would often vary its products, and it would therefore be astonishing if we did not every day see legions of unknown Insects.

But let not these reflections on the origin of insects be regarded with contempt. It is of more importance than at first sight it seems, to be acquainted with the source of multiplication is these little animals. After we are once convinced that they produce themselves by natural means, inseparable from their species, we can declare war against the ancients, we can combat their adherents, and refute those ideas which they have promulgated at the expence of the glory of the Creator. If insects arose from putrefaction, fermented by the heat of the Sun, the same thing might be the case with other Animals and even with mankind.

The

The one is not more impossible than the other; nay there would be a necessity that the thing should actually happen in order to preserve uniformity in the economy of nature. The partisans of the system however, cannot bring a single probable fact to shew that the first man was formed either by a concourse of atoms, or by the heat of the Sun. How than can they pretend to assign such an origin to Insects whose organs and structure are not less admirable than those of the human body? But we have said enough to convince any reasonable mind that creation is the work of a power different from any thing that falls under the observation of our senses. This truth is obvious to the slightest reflection, to wit, that all animals at present existing have descended by regular generation from those which originally received from the hand of God, their figure, their form, their parts, their life and their faculties.

CHAP. II.

Definition of an Insect.

In order to give an accurate description of insects we ought to be intimately acquainted with them; but we are so short sighted, our intellects are so limited, that in general we only see objects by halves. A little knowledge costs us an infinite deal of labour, and sometimes the subjects we endeavour to get acquainted with present unsurmountable obstacles to our research. This is the case with insects, so that

 while

while we confine ourſelves to deſcribe their external parts, it is but juſt that allowance ſhould be made for our defects.

There is a ſtrong analogy between inſects and plants. The latter originate from a ſeed which is nothing but a huſk in which plants, however large they may be when grown, are found entire: Inſects iſſue from an egg enveloped in its ſhell, which encloſes them in all their proportions. Plants grow daily by the acceſſion of alimentary particles; inſects are developed, ſwell and increaſe by means of a nutritive juice. Plants at firſt put forth a ſtem, and afterwards cloathe themſelves with leaves; inſects begin by appearing in the form of a worm, and then acquire wings. The leaves of plants are full of nerves, which divide into a multitude of ramifications; the wings of inſects have likewiſe a vaſt number of ſimilar nerves. Leaves differ from one another in form, and in the ſinuations of their margin; wings likewiſe are varied by their configuration, and by the manner in which their extremities are indented. Plants puſh out flower-buds. Inſects become Nymphs and Chryſalids. As thoſe buds after having flowered give fruit in their maturity; nymphs and chryſalids after a certain time produce perfect inſects. Laſtly, as fruits contain the ſeeds proper for perpetuating the ſpecies of plant which produces them, inſects when arrived at their ſtate of perfection carry alſo within them the ſeed from which ſimilar inſects are to be generated.

Notwithſtanding this ſtriking conformity between plants and inſects, the latter muſt not be ranged in the claſs of vegetables. They are an order of beings higher in the ſcale than plants, and we cannot heſitate in claſſing them with animals. One of our chief reaſons for placing them in this rank is their being

being capable of voluntary motion, whereas plants are rooted to one spot. They have a power of going in search of food at their pleasure; but vegetables can only draw theirs from the spot on which they are placed.

Let it be attended to in general that God hath so restrained the operations of nature that, of the three kingdoms of which it is composed, none of them can encroach on the rights of another. We never see animals become plants, nor plants degenerate into fossils. All maintain the rank which the Creator hath assigned them without being able to quit it. It is remarkable, however, that the matter of which these three kingdoms are composed is the same, and that it differs only in the arrangement which the wisdom of God hath thought proper to give it. The Scriptures do not suffer us to be ignorant of what that matter is. "The earth was without form and "void, and the spirit of God moved on the face of "the waters." GEN. 1. 2. These then are the principles of which God composed the three kingdoms of nature Of the elements of earth and water, are produced minerals, plants and animals of every kind. Of the combinations which the Creator made of these, we see grow, "the herb bearing seed, the "fruit trees bearing fruit after their kind; the mo-"ving creature, that hath life, and fowl that fly a-"bove the earth in the open firmament of Heaven, "and every living creature that moveth." We may go farther, and say that all things originate from water, since the sacred writers have assured us that the earth was composed of it, by the power of the Creator. "He commanded the waters under the Hea-"vens to be gathered together unto one place, and the "dry land to appear; and it was so, and God called "the dry land earth." "The earth, says St Peter, "rose out of the water, and it subsists in the water

"by

"by the word of God." The consequence to be drawn from this is. that the subjects of the three kingdoms of nature differ from one another only accidentally. Indeed it may be said that minerals are only fixed vegetables; that vegetables are volatile minerals and fixed animals; lastly that animals are volatile vegetables that can transport themselves from one place to another according as they have occasion. The whole of these bodies suffer continual changes; vegetables serve for food to animals, and are converted by digestion into the substance of the animal which they nourish. This animal dies and returns to the kingdom of fossils since it is changed into earth, and then rises again in the form of a vegetable. Minerals likewise serve for the food of plants. Vapours exhale from the bosom of the earth, which insinuating themselves through the roots of vegetables, contribute to their growth; and in this way minerals become plants.

These continual transformations evidently shew that the matter of which the three kingdoms are composed is the same. But this is still more sensibly perceived in the dissolution of these bodies. Every thing that exists is composed of the same matter into which it resolves itself; this is a principle that is not contested. What we find then in the dissolution of bodies ought to pass for the matter of which they are composed. Now according to this idea we shall find that plants and animals are formed of water and of earth; for, in the dissolution which takes place daily in these bodies, they at first resolve themselves into water by the corruption of their particles, and when that humidity is evaporated there remains nothing but a mass of earth. But further we may venture to affirm that it would be imposible by art to dispose minerals to undergo the first effects of this dissolution.

tion. A famous Chemist, a man worthy of credit, has at least assured me that they may be reduced to the state of water. I think myself therefore still the more intitled to conclude that all bodies without exception are composed of the same matter and are derived from the same origin.

The distance between the two kingdoms is so very indistinct that it is difficult to say where the one ends and the other begins. We see for instance that corals are the limits between the mineral and the vegetable kingdoms. They are minerals in matter and hardness, vegetables in their manner of growth; and this has made them be classed as marine plants. The passage from vegetables to animals is not less abrupt. Here we find the Zoophytes which the old Botanists supposed to be as much related to animals as to plants. Here also we find Insects which in many circumstances approach to the nature of vegetables but which in others so nearly resemble animals that it is impossible to deny them a place in that kingdom.

On examining insects we find that they are not furnished with bones like other animals, nor indeed have they any occasion for such. Let large and heavy bodies enjoy these for the purpose of supporting their mass of flesh, and of preventing them from sinking under their burthen. But to light and small bodies like those of insects, whose substance properly speaking is not flesh, and which support themselves sufficiently, bones would be of no use. It is likewise peculiar to insects to be destitute of blood. That which is seen on killing a flea or a bug, is only what they have pillaged from some other animal. They have however a sort of lymph, which performs to them the same animal functions which the blood does to others.

If

If we compare insects with the greater animals, they will appear extremely small. Man, the hydra, the crocodile, the whale, the eagle, and the elephant, are millions of times larger than many insects. When likewise we compare insects among themselves, how different are they in this respect from one another? How minute is the fly Serapico, and that which lives on meal, and which we can hardly discern without the aid of the microscope? How minute must not that worm be which is found in vinegar, when according to Mr Leewenhoeck myriads of them are found in a single drop of that liquor! How many times must not a mite, which to our eyes appears no larger than a point, exceed those minute animalcules! And how diminutive does not a mite in its turn appear when compared with the larger insects. It is this comparison, which has obtained for some of them the title Great, which they would not have merited had they been opposed to the animals of large size. It is accordingly in a relative sense that we must understand the term, when we apply it to a species of East India Scorpions, which are nearly a foot long; or to a sort of spiders of the same country, nearly as large as one's fist. These large insects would themselves be very small, when compared to an ox or a camel.

The skin of insects is different from that of other animals. It pretty much resembles parchment, but varies a good deal, in the different species. In some it is tender, in others hard. In the crab it is a sort of enveloping crust. In the oyster a shell in which the animal is enclosed. Some are covered with scales like fishes, others with feathers like birds. Some have a thick and coriaceous skin, others have it smooth, like the human; while others have it rough, like those of quadrupeds. Their body is composed of several rings which are so many different

ent incisures, more or less deep, and often much more so than those of the serpent or lobster.

They have not exactly the same number of members which the other animals are furnished with. The legs are wanting to some, the wings to others; perhaps they may have something less also, or something more in their viscera; but from thence it does not follow that their bodies are imperfect as some philosophers have imagined. An animal is considered to be perfect when it is furnished with all the parts that are necessary for its subsisting in the state appointed for it. The privation of those which are absolutely necessary to another species is no proof of imperfection. A house built according to the rules of architecture, would never be considered as an imperfect edifice, because it had not so many apartments as a palace. The perfection of a compound does not consist in the abundance of its parts, but solely in their proportion and aptitude for the functions they are destined to perform. Each insect is therefore as perfect in its species as the other animals in theirs; and it would be as absurd to deny them this quality as it would be extravagant to maintain that man is not perfect without wings, the horse without fins, or fishes without feet.

These pretended defects, and their diminutive size have made insects be regarded with contempt; but the enlightned naturalist considers them in a very different light. Every Insect however small it may be, is furnished with all the parts that are necessary for it. As no one of them can be taken from it without maiming it, so no one could be added without surcharging it with an useless load; in this its perfection consists. I will not say with St Augustine that the soul of a fly is as perfect as the

fun when it is most brilliant; but I would willingly ask, with that father, what are the springs that put in motion limbs so delicate, which transport those small bodies from one place to another to supply their necessities and which urge and direct their feet or extend and agitate their wings when they run or fly? I agree with him that there are many things marvellous in these functions; but I find still more in the minuteness of the creatures which perform them. If therefore I were to appretiate the soul of an insect, that consideration would appear to me at least as proper for exalting its excellence as the other. Indeed, how wonderful is it to behold organized machines moving and acting, fifty of which put together would not make the volume of a grain of sand! How delightful would it not be could we perceive those parts the delicacy of which is so great that they are invisible to our senses! When we consider all this, what can we think or what can we say, but that God is admirable in all his works, and that the structure of these little animals which creep on the earth, furnishes us with as abundant matter for adoring the power, the wisdom and goodness of the Creator, as the stars which traverse the wide extent of Heaven!

CHAP. III.

Of the Division of Insects.

In considering insects with regard to their external form only, they may be conveniently comprehended in two general classes. The first will include those which have not feet, and the second those which have. Insects of this last class may be subdivided into two different orders. The one have wings, the other want them; and as all those with wings do not resemble one another, hence arises a new subdivision. Some have the wings quite naked, while nature in order to preserve those of others hath covered them with a case. There is besides still another distinction to be made among those with uncovered wings; for in some they are perfectly smooth and transparent, in others they are mealy. In these last the cover is sometimes only partial.

In order to avoid confusion it will be proper never to give the general name of worm but to those insects which are destitute of feet, excluding every other to which the word is generally applied. However this may be, we must enumerate among the insects without feet, the three species of leeches which are known; that of rivers, of stagnant waters and of the sea. To them must be added the Gordius,

 which

which the Germans called the thread-worm, becaufe it is hardly thicker than a thread. The water Tipulæ, the larvæ of the fmall water Tipulæ, which when united in great numbers, form on the furface of the water a kind of green carpet; and a water worm, whofe mouth refembles the opening of a trumpet. In water is alfo found the Infect called the Hippocampus, Sea-worms, and Sea-ftars, and two worms one of which has a large, and the other a fmall probofcis. Earth worms are not in lefs quantity. Befides the common earth worms, there are fome to be found in dunghills, in grafs, in corn, in pulfe, in roots, in wood, and even in the medulla of putrid wood. Many fpecies are found in the leaves of plants. Some fix themfelves on the upper, fome on the under furface, in order to conceal themfelves; fome lodge in the fubftance of the leaves, others in their galls. Some penetrate the fruit of trees, others enter into bee-hives. Some attach themfelves to animals, like thofe which are found on beetles, and which adhere to fifhes, to birds, to dogs, and fwine, and other beafts. Even the inteftines of animals are not fecure from them; fome are found in the entrails of fifhes, of horfes, and of men. Thofe found in man are not all of the fame fpecies, fome are round and long, others round and fhort. Some are long and depreffed, fome fhort and depreffed; and fome are bred in wounds and putrid fores.

Infects with feet, and without wings are very numerous, and have not all the fame number of feet. I know a fpecies of water flea, which has only two. The fpecies which have fix are moft numerous; among thefe is comprehended the Afilus or Oeftrum Marinum, the Corculus, water bugs, land fleas, a fort of mites, which breed in the parenchyma of leaves, certain worms found in ftones, the afelli arvenfes, the aphides of leaves, the Cochineal worm

worm, and ants. Under this laſt ſpecies ought to be comprehended the white and red ants found in the Eaſt Indies, the formica-leo, and the ant of the Philippine Iſlands, called Sinum. In continuing the enumeration of inſects, with ſix feet, we ſhall find worms which devour green and dry wood, bugs, among which I rank the Hocitexca of the Eaſt Indies, and the Ytzuaque of Mechoacan, the lice of bees, of the Dor-beetle, of dogs, of ſheep and other animals: Ticks, mites, fleas, and dermeſtes. The ſame variety is obſervable in the inſects with eight feet; The greater part of ſpiders muſt be ranked in this order; ſuch are many ſorts of foreign ſpiders, aquatic and terreſtrial; ſuch alſo are the Tarantula, the great ſpider of Brazil, called the Nhamdu guaſu; the ſpider or flea, which they call Tunga, and that to which they give the name of wolf; all of which are poſſeſſed of a very dangerous, and often mortal poiſon. Many ſpecies of lice, have alſo eight legs, as well as the land and water ſcorpions, and ſome ſpecies of ſmall caterpillars, which adhere to leaves.

I rank in this claſs of inſects with ten feet, certain ſpecies of foreign ſpiders, and the caterpillars, called Geometræ, the aquatic oniſci have twelve feet, the aquatic fleas, and common caterpillars, the water louſe too, and others have fourteen. The Oniſcus Ceti, has ſixteen. We obſerve eighteen feet in thoſe white caterpillars, ſpotted with black, which feed on the leaves of the Alder. Thoſe worms of the colour of ochre, which are found in rotten wood, and which afterwards change into that kind of beetle, with a proboſcis, (Curculio) have twenty-four feet. Laſtly, there are ſome, which have ſtill a greater number of feet, as many ſpecies of ſmall centepieds and Scolopendræ, both aquatic and terreſtrial. I know in particular two ſpecies, one of them having

one

one hundred and eight feet, and the other no leſs than one hundred and eighty four.

I obſerved above, that among winged inſects, ſome had naked wings, and others had their wings covered with a caſe. The wings of the former, are either quite ſmooth and tranſparent, or covered with a ſort of meal.

Among thoſe with ſmooth wings, ſome have two wings, and ſome four; to the former of theſe belong the gnats, whether of Europe or America; the moſt remarkable of which are, the Maringoin, the Moſquito, the Yetis, and winged ant. To theſe muſt be added, many ſpecies of flies, ſuch as the Aſilus aquaticus, the flies that are found on dung, in the earth, on leaves, and not only thoſe that ſuck the juice of flowers, but of fruits; thoſe that are voracious, and eat other inſects, and the fleſh of ſerpents, and other animals. We refer likewiſe to the ſame claſs, the flies which attack dogs, and horſes, the gad-flies, the Ricinus volans; thoſe that are found on the leaves of the hazel tree, the Ichneumons, which have certain hairs iſſuing from the poſterior part of the abdomen like a tail, ſome having one, two, or three of theſe, and others four; to theſe we add the Taons and Tipulæ.

The number of inſects which have four uncovered wings, ſmooth and membranous, is not leſs great than thoſe which have only two. In this claſs are the aquatic flies with a downy abdomen, waſps, bees, drones, and different ſpecies found in the Brazils, graſshoppers, the ſhining flies, the Ephemeræ, the cricket, and the (Gryllotalpa) mole cricket. To theſe may be added dragon flies, large and ſmall, a ſpecies of gnat called by the Germans, Kerder-mucke, the fly with the ſcorpion's tail, and others of the ſame kind

kind; some winged aphides, the winged scorpion; some aquatic gnats, the ichneumon, and various other sorts of flies.

The insects with mealy wings, as if very fine powder had been strewed over them, have four wings. I include in this class, the day butterflies of every species and colour; the Phalenæ or moths, which during the day lurk in obscurity; the Tineæ, whose wings are as long, though not so broad, as those of moths, and whose body is often not larger than that of a fly.

Speaking of insects whose wings are covered with a case, we distinguished them into two kinds. The cases of the one leave a part of the abdomen bare, and those of the others cover it entirely. Among the first, are various sorts of bugs; the aquatic, some of which swim on their back, those that are found in dung, and those that live on trees. To these we may add, the earwig, the May beetle, the Staphylinus, the Silpha Vespillo, and others of the same kind. Those whose wings and abdomen are entirely covered, have not all cases of the same degree of hardness. In some it is very tender and delicate as in grasshoppers, both foreign and indigenous, in the Mantis of Italy, the Arbe, the Selaam, the Hargol, the Hagab of Palestine, the hooded locust of America, the walking leaf of the East Indies, &c. In others, the covering is much harder, and this class is very numerous. In the first place we enumerate the Buprestis, and different sorts of cantharides, the Dytisci, the Cerambyces, the small hemispherical Lady flies of which the red are the most common, the Curculios, and many others, to which we may join the different species of Scarabœi with horns, both straight and crooked; the flying stag &c.

If

If we contemplate for a moment that prodigious number of different species of insects, some of which we have mentioned; if we attend to the diversity which reigns among them, with respect to the figure and fitness of their limbs; if we consider that each species is furnished with every thing necessary for its existence, but with nothing more; how must we be struck with admiration, and what ideas will we not entertain of the infinite wisdom of the Creator! Should an artist ingenious enough to imitate exactly the figures of these different animals, exhibit them to the view of spectators, how would he find his skill celebrated! The delicacy of the work would be admired, and the author extolled: but what disproportion would there not be between the labour of such an artist, and the productions of the divine workman! Allowing that the former should perfectly succeed in imitating the external appearance of the animal, could we thence conclude that the artist had equalled the skill and wisdom of the Creator? No, there could be no comparison. The master-piece of such an artist would be altogether destitute of that which forms the chief beauty in the works of God, as the sligheft examination would convince us. Where would we see that internal structure which the most inconsiderate are astonished at? Where could we find those wise and subtile springs which move of themselves? What artist could imitate those organs which are so minute as to elude our senses? Let us then be consistent; if we admire the address of a workman even when we confess it infinitely below that of the divine being, let us not refuse to the Creator the glory that is due to him. As much as his wisdom, apparent in the structure of an Insect, transcends that of the most ingenious artist, so far ought our praises of the creator to exceed those we bestow on his humble imitator. On the sight of any insect let us accustom ourselves to magnify the

the depth of the wisdom and knowledge of that God who hath created them; let us never contemplate them without celebrating him, who hath given them life and breath and being. These are the natural sentiments which ought to arise in the hearts of every rational being; and they incited David to cry out, let every creature praise the name of the Lord. As these are not all capable of those sentiments, they cannot praise their Creator but by exciting his intelligent creatures to acquit themselves of that important duty. 'Let them praise the name of the Lord; for he 'commanded, and they were created. He hath also 'established them for ever and ever: he hath made 'a decree which shall not pass away. Praise the 'Lord from the earth, beasts, and all cattle, creeping 'things and flying fowl: kings of the earth, and all 'people, princes, and all judges of the earth; both 'young men, and maidens, old men and children; 'let them praise the name of the Lord; for his 'name alone is excellent, his glory is above the earth 'and heaven.' PSALM, CXLVIII, 5,6,7,10-13.

CHAP. IV.

OF THE NUMBERS OF INSECTS, AND OF THE PROPORTION IN WHICH THEY MULTIPLY.

THE enumeration I made in the last chapter of some of the most common insects, shews that their num-

ber is not ſmall. However, that my readers may be made more fully acquainted with this part of the ſubject I ſhall detail in this chapter, what my own obſervation, as well as the writings of various authors of reputation have taught me with regard to the number of ſpecies included in each of the claſſes under which they I have arranged inſects.

By this means, it will be eaſy to form an eſtimate by calculation of the prodigious numbers which muſt be generated annually.

The ſpecies of aquatic vermes without feet, which are known to me amount to -	18
Sea ſtars, - - - -	105
Vermes, not aquatic, -	37
Inſects with two feet, - -	2
——— ——— ſix feet, - -	69
——— ——— eight feet, -	99
——— ——— ten feet, - -	4
——— ——— twelve feet, -	1
——— ——— fourteen feet, -	6
——— ——— ſixteen feet, -	1
——— ——— above ſixteen feet, -	26
According to the diviſion I have made of winged inſects, I find the ſpecies of thoſe with two ſmooth wings, like tranſparent vellum are, - - -	83
Thoſe of inſects with four ſuch wings, -	69
Thoſe with four mealy wings, -	135
Thoſe with wings only half covered, -	13
——— ——— ——— entirely covered, -	97
The ſum total of theſe numbers is, -	765

Now let us take a ſingle female of each of theſe 765 ſpecies, and let us ſuppoſe that ſhe anually gives birth to ten inſects of her kind, which cannot ſurely be an

an exaggerated ſuppoſition, ſince great numbers of thoſe animals lay eggs by hundreds; the 765 females would produce the firſt year 7,650, the ſecond 76,500, the third 765,000, and ſo progreſſively.

Obſerve, that among the inſects without wings which I have juſt enumerated, I have made no mention of maggots, caterpillars, aphides, &c. which transform themſelves into winged inſects. How many other ſorts of inſects might not be found in different authors unknown to me, or whom I have not an opportunity of conſulting! might not my calculation be infinitely encreaſed by thoſe that live in uninhabited countries, at the bottom of rivers, lakes and ſeas? If all theſe were known, ſurely we would find their numbers almoſt infinite.

But if all theſe inſects multiplied every year according to the proportion ſtated above, and that this took place, without interruption, for five or ſix years, what a prodigious number would not there then be in the world! What frightful devaſtations would they not occaſion! The ravages which a ſingle army of locuſts commits, aſtoniſhes and alarms us; but with what aſtoniſhment and alarm would we not be affected, were we to behold the miſchiefs which many hundred armies of inſects, of different ſpecies, would occaſion, as numerous, and as dreadful as locuſts!

The number of animals which this terraqueous globe of ours is capable of ſuſtaining, is determined by the extent of its ſurface. If in one year they were to multiply to twice or three times their uſual number, the productions of the earth, proportioned to its ſurface, not being ſufficient to maintain them, they would either die of hunger, or prey upon one another. In order to prevent ſuch an inconvenience, God hath wiſely ſet bounds to the life and multiplication of animals.

mals. Those which live long are not prolific, so that the earth is not incommoded with their species. But it is otherwise with those whose lives are short. Accordingly insects which live but for a short time, produce multitudes of young. This numerous multiplication is likewise necessary for them, as many of their eggs perish by the injuries of the weather, and many serve for food to other animals. So wise an ordination prevents the earth from being desolated by a greater number of animals than it can maintain, and preserves a just proportion amongst its various inhabitants.

It is not without justice, that the Scriptures give to God the title of Lord of Hosts. He is the Sovereign of legions of angels, of the armies of Heaven; of that multitude of birds which it has been supposed exceed five hundred species; of the fishes of the sea, and of the waters, of which one thousand different species are known, and of those tribes of animals and serpents, the species of which amount to one hundred and fifty. However numerous these armies may be, those of the different species of insects do not yield to them in that respect. "Lift up your eyes on high, "and behold who hath created these things, that "bringeth out their host by number: he cal-"leth them all by names, by the greatness of his "might, for that he is strong in power, not one "faileth." Isa. xl. 26.

God has not manifested his power only in the creation of this almost infinite multitude of insects and other animals, but his wisdom is also conspicuous. We have observed that a too great multiplication would desolate the earth, which would not then be able to maintain them; but he has ordered it so that there is always a just proportion, never too many nor too few. Without this wise provision we might from time to time lose certain species of animals while others

others might multiply to ſuch a degree as to become really hurtful. Can a balance ſo equal, and in which we diſcover ſo much wiſdom be the work of blind chance? Surely not: what is left to chance is never fixed, never regular. But here we behold a conſtant and invariable proportion which can be nothing but the effect of a deſign premeditated, and of a plan executed by an all wiſe and an almighty power.

How many means has not the God of armies in ſtore for chaſtiſing the human race! All his legions are ready to fly at his command to execute his orders. To mention only the army of inſects, how many means can he not employ to humble the pride of weak mortals! Theſe noxious creatures ſometimes attack the greateſt monarchs on their thrones, they deſolate our fields, infeſt our houſes, and lead famine and death in their train. Though neceſſary to a certain degree, their exceſs is always pernicious. We ſhould be in perpetual fear, did not we know that the Being who regulates their fecundity, loves us, and will not permit them to multiply beyond their proper bounds. We muſt not however flatter ourſelves too much. "All things work together "for good to the godly; but to ſinners they are turned into evil. Fire, and hail, and famine and death, "all theſe were created for vengeance; the teeth of "wild beaſts and ſcorpions, ſerpents and the ſword, "puniſhing the wicked to deſtruction. They rejoice "in his commandment, and are ready upon earth, "when need is, and when his time is come, to obey "his word." ECCLESIASTICUS XXXIX. 27. &c.

CHAP. V.

CHAP. V.

OF THE RESPIRATION OF INSECTS.

RESPIRATION is that action of the lungs by which the air enters the bodies of animals and is expelled again without intermiſſion. It is one of the moſt important functions of animal life, and without which no creature could ſubſiſt; accordingly we find that every thing which lives reſpires, or performs ſome function nearly approaching to reſpiration. It was the neceſſity of this continual motion which determined the Creator to form in living creatures, thoſe admirable organs which perform it. It is the ſame neceſſity too which makes us generally confound reſpiration with life, and conſider theſe things as ſo ſtrictly combined that they can never exiſt apart. It is not merely in common language, that theſe two terms are conſidered as ſynonimous; the Scripture itſelf often uſes them indifferently. Moſes, meaning to indicate the deſtruction of all animals by the waters of the deluge, ſays that "all "fleſh died that moved upon the earth, both of "fowl and of cattle, and of beaſt, and of every "thing that creepeth upon the earth, and of every "man; all in whoſe noſtrils was the breath of life, "of all that was in the dry land died." GEN, vii. 21,22. David alſo expreſſes himſelf in the ſame manner, ſpeaking of the death of animals; "if thou takeſt away their breath, they die and re-"turn to their duſt." PSAL. civ. 29. St Paul, in

in the discourse he made at the Areopagus, likewise places respiration among the best gifts of the Deity: "he giveth to all life, and breath and all things."——ACTS xvii. 25. An action so necessary, and which is at the same time common to all animals, requires that I should stop a moment to consider it, and endeavour to display all the skill and the wisdom of him who is its author.

Some antient philosphers, supposing that insects had neither wind-pipe nor lungs, have denied their respiration; but the air pump, invented by Otto Gerickin, and various experiments have convinced the moderns of the contrary. If we put an insect under the receiver of that instrument and then pump out the air, it first grows weak and then dies. It is not therefore to be doubted but that insects like other animals have both wind-pipe and lungs. The first gives a free passage to the air and the last like a bellows inhale it when they dilate, and expell it when they contract. If we stop the wind-pipe of animals they can no longer breathe and they die: the same thing happens to insects when their respiration is obstructed. All insects have not the wind-pipe in the same place of the body. In some it is found at the mouth, others in the extremity of their body toward the tail, in which they differ from all other animals.

All sorts of air are not proper for respiration; it must be temperate; air either too thick or too thin would destroy life; the one makes animals die in a very short time, and a too long abode in the other does not fail to produce the same effect. But however necessary air may be for life, some there are which can dispense with it for four and twenty hours. If at the end of this period air is restored to them they

they recover their ſtrength and do not appear to have been incommoded.

But what deſerves our particular attention is, that theſe minute creatures, though air is ſo neceſſary to them in ſummer, live during the winter with very little reſpiration if any at all. They are then in a ſort of ſleep or lethargy, in a ſtate between life and death. The ſalt and the viſcid humour which tranſpire from their bodies grow hard by the cold, and form a ſpecies of cruſt around them. In this ſtate the pores of their bodies are contracted and in a manner ſhut: the vital ſpirits are concentrated in the interior parts of the inſect, and they loſe nothing of them by tranſpiration. As they make no motion, nothing is diſſipated: they remain always in the ſame ſtate, and have no occaſion to reſpire in order to acquire new ſtrength.

We cannot ſufficiently admire the goodneſs of the Creator in providing for the wants of his creatures. If air is neceſſary for their exiſtence, he gives it to them. The quality and quantity of this cannot be the ſame for all animals; he gives to each the organs neceſſary for inhaling juſt what is ſufficient for them, and the kind that ſuits them. He weighs and deſtributes it to them as it were by meaſure. Men enjoy this precious gift in the ſame way with inſects; but how few are there who have given themſelves the trouble of reflecting on a benefit without which it would be impoſſible to live. How have they requited Him for it? From our birth we have breathed, the air is common to all animals, and they enjoy it without labour or expence; and therefore inſtead of being grateful, men become inſenſible to ſo precious a gift. As each inſpiration and each expiration are ſo many authentic teſtimonies of the power, of the wiſdom and the goodneſs of God, there is not a moment

moment of our lives which does not invite us to celebrate his perfections and to expreſs our own gratitude. The Pſalmiſt was penetrated with the juſtice of this reflection. "Let every thing that hath breath "ſays he, praiſe the Lord." PSALM CL. 6.

CHAP. VI.

OF THE GENERATION OF INSECTS.

WHEN a living creature produces another of the ſame ſpecies with itſelf, we ſay that it has engendered it. All generation is preceded by an intercourſe between the male and the female. This is a general rule from which inſects are not excepted; the only difference to be remarked with regard to them is, that the way in which the male inſects couple with the females is different in different ſpecies. However, this commerce fecundates the female and puts her in a condition to lay her eggs when the ſeaſon has arrived. The Ephemera is ſingular in this point; for it is only after the female has depoſited her eggs on the ſurface of the water that the male fecundates them.

The variety among the eggs of inſects is incredible: it may be ſaid to equal the number of ſpecies. Without conſidering the difference in their ſize, I ſhall only remark the moſt ſtriking diverſities among them whether from their figure or colours. The moſt common figures are the round, the oval, and the conic; but it muſt be attended to that there are ſome more and ſome leſs ſo, and that ſome approach more to theſe figures than others. As to colours the dif-

ference is more ſtriking. Some like thoſe of ſome ſpiders have the ſplendor of little pearls; others like thoſe of the ſilk-worm are yellow and of the colour of a grain of millet. Others are of the colour of ſulphur, of gold, or of wood. Laſtly there are ſome green and brown, and among theſe laſt there are various tinges of brown, ſuch as yellowiſh brown, reddiſh brown, cheſnut, &c.

The matter which theſe eggs contain is at firſt a liquid ſubſtance, and afterwards forms the inſect, which is very artfully encloſed in the ſhell. There it remains till the ſuperabundant humidity is diſſipated, and its members have acquired ſtrength enough to break the egg, when it comes out. At this period it makes a hole in the ſhell raiſes up the little broken pieces, ſtretches forward the head, which hitherto had been bent in towards the belly; diſplays its antennæ, and puts them in motion; brings out its legs one pair after another, attaching itſelf with the firſt pair to the egg, till the whole body is drawn out.

All inſects do not remain equally long in the egg. A few hours is ſufficient for ſome, while it requires many days, and even many months before others break their priſon. Eggs, which during winter have been in a warm place, ſoon loſe their humidity and are hatched prematurely. It is worthy of remark, and muſt not be forgotten, that thoſe caterpillars which live on green vegetables, never leave their eggs till the herbs and leaves they feed on are ſufficiently advanced. Providence has been careful to provide for their neceſſities, and to inſure them of food the moment they want it.

Another circumſtance not leſs remarkable, is that many of theſe eggs, notwithſtanding their minuteneſs and delicacy are able to reſiſt both cold and wet which do not deſtroy them. But even though num-

be

bers of them ſhould be deſtroyed, that loſs would be eaſily repaired by the fertility of the females. One inſect generally lays a great number of eggs; from thirty to ſixty and even ſome hundreds. This I learnt by the following circumſtance. On the 6th of June 1736, a foreſter brought me a butterfly, the upper wings of which were dark, ſpotted with eight white ſpots, and the under wings orange coloured. I fixed it with a pin to a board, and on the afternoon of the ſame day, found that it had laid four hundred and thirty one eggs of the ſize of a grain of millet, which reſembled ſmall pearls. At firſt they were ſoft, as I eaſily perceived becauſe they were flat on that ſide which reſted on the board, and reſembled the top of a loaf. Their figure cannot be obſerved while they lie one upon another; they muſt be detached to have a diſtinct view of them. In ten minutes they became ſo hard that when they were pierced with a pin they cracked like the ſhell of a pullet's egg. The liquor that iſſued from them was whitiſh like water. When put into the microſcope, they appeared ſemi-tranſparent like a hog's bladder. The next day the ſame butterfly had laid 170 eggs making in all ſix hundred and one.

The obſervation I have juſt made to ſhew the fertility of inſects will likewiſe prove that eggs are ſoft when diſcharged by the female; this I was convinced of likewiſe by another experiment. I took a butterfly of another ſpecies which I fixed to a board like the other. As ſoon as it had laid an egg I touched it with the point of a pin, and found that I could make little pits in it, nearly as in a bladder which is not quite blown. Some minutes afterwards theſe eggs became hard, and when I preſſed them ſtrongly, they broke in ſeveral places like the eggs of a pullet.

At first nothing is seen but an aqueous matter; a little time however discovers in the middle, a dark point which afterwards becomes the insect. In this it is entirely enclosed, but it cannot be perceived without the aid of a good microscope. Under the hard shell of the egg is found a pellicle, fine and delicate, in which the insect is wrapt up as in a matrix. It is there rolled up with so much art, that notwithstanding the smallness of its apartment it has abundance of room, and is furnished with all the members it ought to have. When we view the surprising compactness and disposition of the whole, we cannot sufficiently admire the wisdom of him who has confined so much matter in so little space. The insect as I have already said remains in this state till having become larger it acquires strength sufficient to burst its prison walls and to come forth.

The little care which insects take of their eggs deserves the reader's attention. After having deposited them, they leave them, and go away without any further concern; they resign the labour of hatching them to the nature of the place where they are laid, and to the heat of the sun. In due time the caterpillars issue from the eggs without any defence against the injuries of the air. By this they are distinguished from the rest of all other animals. A woman nourishes and protects the child in her womb for nine months; the females of quadrupeds do the same with their young; birds lay their eggs in nests, and hatch them with the most diligent and painful incubation. Fishes alone in this respect resemble insects; they lay their spawn upon the shore without any other precaution than that of chusing a place they think the most proper for depositing it in; they then abandon it, and the young are brought forth without the assistance of their parents.

As

As insects produce such a number of eggs it is easy to conceive that there must be a proportionable number of the animals themselves. It is no doubt for this reason that the Scriptures compare numerous armies to insects. The author of the Book of Judges in order to give an idea of the multitude of Midianites, and Amalekites, says, that "they came with their "cattle as grasshoppers for multitude, and they en-"tered into the land to destroy it."——Judges vi. 5. The Prophet Jeremiah makes the same comparison in speaking of the troops which Nebuchadnezar was to bring into Egypt. "They shall come against her "with axes, as hewers of wood. They shall cut "down her forest, saith the Lord, though it cannot "be searched, because they are more than the grasshop-"pers, and are innumerable." Cap: xlvi. 22,23. The miseries that were to afflict Nineveh the great, are represented by Nahum under emblems drawn from insects. 'Make thyself many, says that Pro-'phet, as the canker-worm, make thyself many as 'the locusts. Thou hast multiplied thy merchants, 'above the stars of Heaven; the canker-worm spoi-'leth and flieth away. Thy crowned are as the lo-'custs, and thy captains as the great grasshoppers, 'which camp in the hedges in the cold day, but 'when the sun ariseth they flee away, and their place 'is not known.' Chap. iii. 15,16,17.

One thing which contributes greatly to the prodigious multiplication of insects is the little time they require from their exclusion by the parent female to their being capable of laying eggs themselves. This is so rapid as to have given occasion to a vulgar saying that the louse may be in four and twenty hours a mother, a grand-mother and a great grand mother. We must not therefore be surprised that insects multiply so remarkably, and that such pains are requisite to destroy them.

What

What I have said in this Chapter might furnish abundant matter for reflection. It is allowed that insects are destitute of reason; the wisdom therefore of their conduct, the justness of their precautions, and in a word every thing they do which is agreeable to reason, does not proceed from themselves. From whom then do they derive it? Who hath taught them the season and the manner of propagating their species? Who hath directed them to lye with such compactness in their eggs without being in the least uneasy? How do they know the precise moment when it is proper to issue from their eggs? Who hath prescribed to each species the number of eggs it is to lay? Who hath endowed them with the power of resisting the inclemencies of the weather and of coming forth without incubation? One must be wilfully blind not to acknowledge in these traces the hand of an all powerful Being whose wisdom is unsearchable. Who but he could have made them capable of so many different functions, and have endowed them with instinct to perform them? A great number of eggs of insects perish, and animals devour another part. Had not providence supplyed the loss by the promptitude with which they encrease and their great fertility, the various species would have been in danger of perishing, or at least would not have been produced in sufficient quantities to feed the other animals that depend on them.

CHAP. VII.

CHAP. VII.

Of the Transformation of Insects.

The subject I am to treat of in this Chapter is so singular, that it is peculiar to insects alone; and as there is nothing resembling it among the other animals, it deserves our particular notice; and the rather because if we are not attentive to the transformations of insects, and do not know exactly all the forms which the same individual successively assumes, we shall be in danger of making two or more insects of one and the same animal.

It is not the actual substance of the insect which undergoes a transformation; it is merely the external form which is changed. The parts it is composed of, after its metamorphosis, are enveloped and masked as it were under different skins, from which the animal disengages itself, successively, as it grows in bulk, and at last appears with all the members necessary for it in its last state. When the period of transformation arrives we often see caterpillars quitting the leaves and plants they have hitherto fed on, and transporting themselves to a more commodious place. Some however do not abandon their first situation, but attach themselves to the stems or branches of the plant which has formerly afforded them protection and support. Then as if loathing the food they had at first greedily devoured, they cease altoge-

ther to eat. So ſtrict a faſt is undoubtedly neceſſary to prepare them for the change they are about to undergo: and this ſeems the more probable as they diſcharge all the fæces their inteſtines are filled with, before they attempt the change.

The metamorphoſes of all inſects do not reſemble one another, but are generally divided into four different claſſes. The firſt comprehends thoſe inſects which after being formed in their egg, without the aid of food, and which after having taken, by the evaporation of the ſuperabundant humidity, the neceſſary conſiſtence, quit that ſtate and iſſue from the ſhell under the form they are to retain during life, without undergoing any other transformation. To this claſs belong ſpiders, lice, fleas, the oniſci, the Iuli, &c. The transformation of the ſecond claſs conſiſts in this, that the inſect which was encloſed under a diſguiſed form in an egg, and without food, after having been fortified by the evaporation of the ſuperabundant humours, leaves the ſhell and appears under the form of an Inſect without wings with all its other appropriate members; which in this ſtate eats and grows till having entred a ſecond time into what is called the Nymph ſtate, it iſſues from that ſtate with wings and is capable of propagating its ſpecies. I include in this diviſion, ants, dragon flies, graſshoppers crickets, the mole-cricket, cimices, aquatic flies, &c. In the third transformation, the animal, after having iſſued from the egg where it alſo lay in a diſguiſed ſhape, and without food, appears under that of an inſect which eats and grows, while the members of the animal into which it is to change, are formed under its ſkin, which it at laſt quits, and becomes a nymph or chryſalis; and then after the evaporation of the ſuperfluous humidity, is transformed into its laſt ſtate, which is that of a perfect inſect. This claſs includes bees of all ſorts, gnats, beetles, butterflies,

and

and moths. In the last sort of transformation, the insect, after having arrived at the nymph state, like those before mentioned, does not divest itself of its skin in order to enter into that state, but assumes the form of a nymph under its skin, where it continues shut up, till quitting two skins at once, it comes forth in its perfect state. This is the metamorphosis which flies, Ichneumons, &c, undergo.

Besides these changes, insects several times cast their skins; but this does not happen to them all at the same time or in the same way. Some, as spiders, change their skins only once a-year; others as grasshoppers, and the cabbage caterpillars change it four times; and others even six times. The greater part quit it entirely, but some retain it attached to the extremity of the abdomen, and carry it over their head to defend them from bad weather, or other insects their enemies. This is the case, as Frisch observes, with the Cassida nebulosa. The manner in which they divest themselves of it, varies also according to the diversity of species. In some it is rent near the top of the head, and the insect puts it off as one draws off a stocking. In others it is first torn under the belly, and they throw it over their head as one does a shirt. The spoils of many insects preserve exactly the figure of the animal, which is particularly remarkable in those of spiders. Some of these cast skins, are lined internally with a white membrane much more delicate than the outer one. When thrown off, they are sometimes so contracted as not to retain a third of their former length; at othe' times they appear swollen, and discover nothing b the hole through which the insect made its exit. in

, not

When the insect has thrown off its last skiy the pears in the state of a nymph or chrysalis rench-

I method

of

are only covers under which the animal is formed, and which it preserves till it has taken its natural shape. These nymphs are soft at first, and contain some liquid matter which in time evaporates, and they acquire more consistence; but in general they are very thin and fragile.

Insects in this state may be divided into two classes. There are some of a conical shape, almost of the figure of a date; others of an angulated form, with sharp corners at the rings and anterior part, and little elevations at these corners. There is a great diversity in their figure. Without mentioning those that are of the form of a date, some have the appearance of a child in swaddling cloaths laid in a cradle; others have the face of a man. Others resemble the head of a dog, a cat, a bird, a mouse with its tail, and even of the Insect itself which is to proceed from it.

The limbs of insects are not folded with less art in chrysalids and nymphs than they are in the egg. It is wonderful to see the artifice with which they are disposed, and the wisdom which has contrived to lodge in so small a space, so many different members without hurting them, or producing the least confusion. In some we may perceive externally all the limbs of the animal it encloses; others are so transparent that the insect is easily discoverable upon looking through it: but others must be opened before we can judge of the insect they contain.

i.. Great variety is remarkable in the colour of chry-
theilids.. Brown, yellow, red, green, white, violet and
nndeck are the chief; but it must be observed that
nymph colours appear in various degrees, and that
the supe different shades of them may be perceived in
state, wnt sorts of chrysalids, and in some mingled
includes tmuch art, that the eye is astonished in view-
The ancients imagined that the beauty of
the

the colours in a chryſalis was a proof of the beauty of the inſect it contained; but nothing is more deceitful; we might as well ſay that the beauty of a cradle was an indication of the beauty of the child that ſlept in it. Beſides, experience teaches us that a plain inſect very often iſſues from a gilded chryſalis, while another with a leſs ſpecious appearance often produces a very gaudy one.

No motion is perceived in ſome of thoſe inſects while they continue in this ſtage of transformation; but as this incapacity of moving themſelves might expoſe them to be devoured by their enemies, they ſhelter themſelves under a ſtone, a root, or a piece of wood. This is not all, they make that ſide which is expoſed, ſo round and tenſe, that worms cannot lay hold of them. They are not however all motionleſs. Some ſpontaneouſly agitate themſelves, and others do not move except they are touched. Theſe laſt, on ſuch occaſions move their abdomen and ſhake their heads as if to defend themſelves, and intimidate their enemy. There are likewiſe ſome (as the Dytiſcus latiſſimus) which when turned upon their back, inſtantly replace themſelves, in their firſt ſituation. Others, (as the Coccinella ſeptempunctata,) turn themſelves round for ſome time. Others though they are in general motionleſs, if they are taken into the hand, ſeem to be revived by the heat which puts their humours in circulation, and makes them perform various contorſions. But neither the one nor the other take the leaſt nouriſhment during the time they continue in the pupa ſtate.

The precaution of chooſing a convenient place in order to preſerve themſelves from injuries, does not always appear to them ſufficient; they fortify the place they have choſen with a kind of entrenchment againſt attacks from without. The method

of some is to suspend themselves by the tail to threads which they draw from their own bodies, and thus they are safe from the attacks of creeping insects, and they hold so firmly by these threads that they are not easily detached. Others weave around them a web with large meshes, nearly resembling a fisher's net: this keeps at a distance from the centre such insects as might injure them, and prevents their being hurt by the fall of any body. These two precautions are peculiar to those only which have skins sufficiently thick to resist the inclemencies of the weather. Those which have not the same advantage cover themselves with a particular sort of web. Some spin cones of silk, others discharge from the pores of their body a sort of long wool which covers them during all the time they remain in the nymph state. Many fortify these cones with their hairs, which they divest themselves of, (as the Phalæna Caja;) and those that have no hairs, and also want silk, gnaw pieces of wood, and employ the small bits in fortifying the inside and outside of their mansion, as is the practice of the Phalæna aceris. Some of these cones are so hard and so well constructed that they are with difficulty torn; they may be properly compared to parchment. To connect the threads together, they moisten them with a sort of gum which issues from their bodies, and which gives their work the necessary degree of hardness. The cones are not all of the same figure. The greater part are oval or spheroidal, but there are some that represent an egg cut longitudinally. They are attached by the flat side to something solid which may contribute to their safety. The precautions of some are not confined solely to this external one: in order the better to shelter themselves against the inclemency of the weather, they cover it with a leaf, or many leaves gathered together: others enter into the earth and hide themselves there, but for fear of its falling, they either plaster the walls

walls of their residence with a sort of viscid substance or line them with silk.

The period of their change into chrysalids or nymphs is fixed. Some change in May, some in June; others in July, August and September. The time of emerging from this state is also regulated. Some remain in it only twelve days, while others continue fifteen, sixteen or twenty. Some do not get free from their prison so soon, but are detained there three weeks or a month; others even two months, others six, others nine, ten, and even some a whole year; as the Phalæna Absynthii. It is easy then to conceive that insects must issue from their cones in different months of the year. We find them appearing in the months of February, March, April, May, June, July, and August, and even in November and December. Some insects have this remarkable property, that they produce two broods that issue from their prison at two different seasons of the year, and present themselves on the theatre of the world; for it deserves particular attention, that they never come forth, but at the time when there are plants and leaves sufficient to furnish them with food. Without this wise ordination of the providence of God, these little creatures would perish at their birth.

May I not now be allowed to ask if these transformations can be the effect of chance? If they were, is it possible that there could be so much regularity and order in the different particulars necessary to operate such wonderful metamorphoses? Whatever is the effect of chance is subject to no fixed, no determinate order. To day it operates in one way, to morrow in another, but here all is regular without the shadow of variation. Who is it then who has taught these insects to accomplish what is necessary, each

each according to its species, for passing from one state to another? How do they know that in order to defend themselves, they have need of a cone more or less strong according to the greater or less degree of delicacy in their constitution? Whence comes it that these animals, without the aid of reason, are found folded in their cones, with so much art, that however narrow their mansion, they have enough of room, although were their members extended, three times the space would not be sufficient to contain them? From whom do they receive that sagacious foresight, which prompts them to take the proper measures for securing themselves against external injuries? Who hath instructed them to choose the most safe and proper places for undergoing their changes? What artist has taught them, to weave their various webs, in which the chrysalis is as softly laid as if it were on down? By what means are they informed of the precise time when it is necessary to construct their habitations and to retire to them. Whence comes it that the period of remaining in their cones is so regulated that they never leave them except in the season when they are sure to find food? I cannot but acknowledge in all this, distinct traces of the boundless wisdom of the Creator. No, a blind cause could not operate such wonders; it must be infinite, and sovereign intelligence: and since insects are incapable of so many perfections, it can be no other than a Deity who has created them, and who governs them by his Providence.

CHAP. VIII.

Of the Sexes of Insects.

Modern philosophers as I have already remarked have well observed that insects are produced by generation. The experiments they have made on this subject, have even taught them to distinguish the males from the females, and they have described the marks by which they are to be known. The detail of these marks is the subject of this Chapter.

In the first place the male is distinguished from the female by its size. He is generally shorter and more slender than the female, which is undoubtedly the effect of wisdom in the Creator. The females being obliged to carry a great number of eggs, it was necessary that they should be larger and thicker than the males that they might have room to lodge their eggs.

They are also distinguishable by their antennæ. Those of many males are pectinated, of the females plain. Lister observed that the males of spiders have eight eyes with knobs at the extremities of the antennæ which the females have not. The antennæ of some other insects are distinguished in the same way. Those of the male are smaller, shorter, and more opposite to each other.

The

The wings are a third discriminating mark be- [illegible] m [illegible] male. In some species the male only is furnished with them, the female either wants them altogether or has them very short. In other species where both sexes have wings, there are some which bear on those wings the characters of their sex. On those of the male are perceived small spots which are not found on those of the female.

Insects which insert their eggs into the bark of trees, into the earth, into the substance of leaves, or into other insects, are furnished with a tube longer or shorter for the purpose of penetrating to the place where they wish to deposit them. This tube, which serves as a passage to the eggs, affords another mark of distinction between the sexes. As the male has no occasion for it, the Creator has bestowed it only on the female.

We discover the sexes likewise often by their colours. The beauty of the male generally exceeds that of the female, his colours being more brilliant and shewy. This rule however is not without exception, for the females are sometimes more beautiful than the males.

Lastly, they are distinguishable by the sound of their voices. This seems to have been bestowed on some insects solely to procure them the means of approaching each other for the purpose of generation: and therefore the male alone has organs proper for producing a small sound in order to attract the female. This rule however like the former is not general. There are species of insects in which both sexes are provided with the organs necessary for producing this sound.

It

It is not without reason that God has thus impressed marks of distinction on the different sexes of animals. He has provided in this way for their multiplication, to which the male as well as the female are incited by an instinct so natural, that they suffer if they do not indulge it. It cannot be doubted that this is the immediate operation of the Deity; on this point the Scripture is decisive. After having related the creation of man, it adds that "God created them male and female, that he blessed them, "and commanded them to increase and multiply, "and replenish the earth." Gen. i, 27, 28. Shall we say that this law respects man only, and that insects are excepted from it, because there is no mention made of them? the contrary will appear evident from the seventh Chapter of the same book. God irritated against the human race, resolved to destroy them by the waters of the deluge. But as this could not be done without exterminating, at the same time, all the terrestrial animals, he commanded Noah to take a pair of each species that they might replenish the world anew. "Of every clean beast, says "he, thou shalt take to thee by sevens, the male "and his female; and of beasts that are not clean "by two, the male and his female. Of fowls "also of the air by sevens, the male and the female." and why? "to keep seed alive upon the face of all "the earth." Gen. vii. 2, 3. That insects are comprehended in the number of these animals is evident. 'In the seventeenth day of the second month 'Noah and his family entered into the ark; they 'and every beast after his kind, and all the cattle 'after their kind, and every thing that creepeth upon 'the earth after his kind, and every fowl after his 'kind, every bird of every sort. And they went in 'unto Noah, into the ark, two and two of all flesh, 'wherein is the breath of life. And they that went 'in, went in male and female of all flesh as God

'had commanded.' GEN. vii. 11-16. Insects therefore are not excepted from this general law. God hath made them to preserve their species by the intercourse of male with female; God hath endowed them with the proper organs for this purpose. God in short, hath blessed them like the other animals that they may multiply and replenish the earth. The effect of this benediction has subsisted for thousands of years without our being able to observe any alteration. What exalted idea ought not this to give us of the power and wisdom of him who hath established so permanent a regulation, and which has not suffered any interruption in the course of so long a succession of ages!

CHAP. IX.

OF THE ABODE OF INSECTS.

THERE is hardly any substance in nature which does not afford a lodging place for insects. Of this I mean in the present Chapter to convince my readers.

Water is not an element proper for every sort of animal. Those who are not furnished with organs that fit them to inhabit it, perish in a short time, when by any accident they fall into it. If it had not pleased God to form creatures capable of sustaining life in that element it would have been desert; but besides fishes of every kind, he has created a great number of insects to inhabit the waters. As among those there are many which cannot live but in salt water, so among these there are many which

which would perish in fresh waters. On the other hand, the saltness of the sea would kill many which cannot live but in fresh waters. Hot springs, in which a person cannot hold his hand without being burnt, would seem to be a very improper abode for living beings; and yet there are insects found, which live and thrive in them, and die when taken elsewhere. It is well known that these little creatures very much dread the cold, which generally benumbs them; would one then expect to find some in snow? We know likewise that offensive smells and oily substances are injurious to them, yet some inhabit the water of dunghills, in which both these inconveniences are united. There are even Naturalists who pretend to have discovered some in fire; but I doubt the truth of their observations. Fire is an element which destroys and dissolves every thing! how then should an insect resist its action? It is very certain that they are found both in natural and artificial liquors. The curious have perceived them in the bleedings of the vine newly drawn, in wine, in vinegar, and in infusions of every kind; a phenomenon the more surprising as the greatest part of insects have an aversion at every thing which is acid or pungent, as some of these liquors are. Lastly there are amphibious insects as well as other animals. Many species live equally well in water or in air. They delight to be in the vicinity of water, on the surface of which they are seen flying, and serve for food to the animals of both elements.

The earth, both in its surface and below it, is not less peopled with numbers of insects than the waters. Some have no other domicile than below the surface of the earth; others may retire thither for protection against the rigours of winter; hence many derive the names which distinguish them from other species. For example, we call those flies, larvæ and spi-

ders which live in the earth, land insects, to distinguish them from others of the same kind that live elsewhere. It is not indifferent to them what soil they make use of; they are seen seeking with anxiety for that which is fittest for their purpose, and there they fix. Others make vaults underground, through which they creep and walk; others content themselves with a hole which they fabricate with wonderful art, and in which they nestle. Grasshoppers delight in a dry soil, and crickets love to dwell in walls constructed of mud. Earth newly dug, swarms with insects, some of which feed on the roots of plants, and others on the earth itself. Some live only in sandy soils, others only in that formed of rotten wood. Some lodge in the fat and putrid earth of dunghills, and find what is necessary to life in a place which would kill other insects. In this class I rank flies, some beetles, and the larvæ of dunghills. Others seek their food in the excrement of animals, and are found in it both before and after its exclusion. Some put themselves under stones which serve them as a canopy; while others gnaw them, however hard, till they have excavated a hole in which they can lodge. Lastly they are found in vast numbers on the surface of the earth; such are the land pulices, grasshoppers, millepieds, &c.

There is hardly a plant which does not nourish some insect. Some people even affirm that each has a species of insect peculiar to itself; but it also often happens that the same plant serves as a residence to many species of these little animals. Some creep in the grass, or construct in it dwellings for themselves. Others lodge about the roots of plants, or fabricate small apartments near them; some lastly harbour in the bulbs of flowers.

The grass is like a large carpet on which many species

ſpecies of inſects are found. The larvæ of all ſorts of inſects are found on the wormwood, the cabbage, the borrage, the nettle, on fennel, flax. ground ivy, motherwort, chervil, mint, creſs, orach, bugloſs, melilot, aniſe, plaintain, and ſpurge. Some lodge between the two membranes of the leaf; the under one ſerves them for a bed, the upper for a covering. Others which have derived their name from the circumſtance, roll up the leaves like a cylinder; attach the different folds with a thread which they draw from themſelves, and ſhut themſelves up in it. Laſtly ſome are found fixed on flowers. The anemone, the flowers of the wild creſs, of hyacinths, July flowers, larkſpurs, roſes, violets &c. ſerve as a habitation for many ſpecies,

Nothing is ſecure againſt the voracity of theſe importunate gueſts; they ſpare no ſort of fruit whether dry or green. They are found not only on the leaves, the ears and ſtems of corn, but alſo in the dried grain; ſuch as peaſe, beans, oats, &c. and in the bread made of theſe.

They mount up on ſhrubs and lodge there. They delight in the hawthorn, the elder, the gooſe-berry, the quince, the vine &c. Some keep themſelves on the outſide of the leaves, while others penetrate within, between the two membranes, attach themſelves to the flowers or inſinuate themſelves into the wood itſelf, and there cauſe ſmall excreſcences.

The larger trees are worlds peopled with various ſpecies of inſects, and there is hardly a part of them which theſe little animals do not attack. Some that have acquired the name of *ambulones*, do not confine themſelves to a ſingle tree, but go from one to another, ſeemingly deſirous of taſting all. Others are more conſtant, and attach themſelves to the root, the bark or

or wood of the tree, and keep fixed there. The taste of these last varies. Some prefer green to rotten wood, others esteem dry wood before what is moist, and are better pleased with those places in which corruption has begun, than with those that are sound. Some live on the leaves of trees, as the lime, the mulberry, the alder, the willow &c. Some insinuate themselves within the parenchyma of those leaves, and live between the two membranes which cover them, while others are the cause of an excrescence in which they lodge. These are of many species; and it is easy to know them by the different form of the excrescence they live in. Some make it of a round form either on the upper surface of the leaf, as those on the beech, or on the under surface like those of the oak; some on the margins as those of the willow, others give it the figure of a cone like those on the lime. The flowers of trees have likewise their inhabitants. Insects are found on those of the cherry, the apple, the plumb, the hazle, &c. nay, they penetrate the fruit, and spoil our apples, pears, figs, cherries, nuts, &c.

But it is not plants alone that insects chuse for their abode, they likewise effect a lodgement in animals and even in other insects. It is well known that the ichneumon flies lay their eggs in the bodies of caterpillars and spiders where they are afterwards hatched. Before this fact was perfectly ascertained it was easy to fall into error, and to believe that one species of insects sometimes produced a species different from itself. Can we be surprised then that some naturalists should advance this paradox? Some are found attaching themselves to the outside of another insect without penetrating further; thus we find a sort of lice on aquatic insects, on bees, butterflies and beetles. Serpents likewise nourish many insects. I have not yet been able to discover

discover if animals covered with a hard shell, such as crabs, are infested with any sort of vermin; this is not impossible, since some writers affirm that they have found such on shell fish. Oysters are said to have insects with many feet in them, and we see evidently that the shells of sea snails and muscles have been eaten by worms.*

Fishes though living constantly in water, and having their bodies covered with scales, are not exempt from the insults of insects; these attack the most monstrous whale, as well as the smallest fish. Some harbour under the scales, as under a roof; others attach themselves near the very eyes, and adhere so strongly, that notwithstanding the rapidity of the fish, it cannot shake them off. Others insinuate themselves under the ears of whales, and are there nourished; others pierce the flesh, and penetrate so deeply, that they cannot be seen or expelled. Some glide into the intestines which they pervade in all directions; or settle in the stomach.

Many authors have observed that insects harbour in the feathers of birds; not however always in equal numbers; for in autumn, there are fewer of them than at any other season. The cause of this may be, that they are then fatter, and that they have imparted a good number of these attendants to the young they have hatched. Those who have the care of poultry yards, know that pullets and geese, are attacked by vermin, and this is perhaps the reason why hawks are so tormented with them. The birds they seize, communicate these vermin to them which they never can afterwards rid themselves of. If we may believe the testimony of authors, cranes have also a great number of insects adhering to them. The same is to be said of Peacocks, and Turkies; but few birds are more cruelly infested with them than pheasants.

fants. They would be eaten into the bone by vermin, were they not to duſt themſelves often, in order by this means to get rid of their troubleſome lodgers. Storks and pigeons are alſo very ſubject to them. It is ſaid that there is a bird in the Brazils, called Taputa, which conſiſts of nothing but ſkin, and bone and vermin. These inſects do not fix indifferently on all parts of the bird they adhere to. Some lodge under the ſkin, particularly about the neck, where the bird cannot eaſily get at them with his bill; others on the quills of their feathers; others on the wings &c. An attentive obſerver with little trouble may eaſily convince himſelf of theſe facts.

Inſects do not leſs infeſt quadrupeds than birds. The Gad-fly pierces the ſkin of cows, deer and hogs, and depoſits its eggs; the larvæ afterwards neſtle between the ſkin and the fleſh. Some are found in the heads of various animals, but chiefly in thoſe of the deer kind. To this ſome people have attributed the annual caſting of their horns. They inſinuate themſelves alſo into the noſes of different quadrupeds. Shepherds know but too well how fatal they are in this caſe to the ſheep they attack. Some penetrate even to the inteſtines, and move there as if in long galleries. Such are found in the inteſtines of horſes; but beſides theſe, what vaſt numbers of inſects attach themſelves externally to quadrupeds? Some flies chiefly infeſt dogs, others horſes. Different ſpecies of pediculi adhere firmly to the ſkins of aſſes, dogs, horſes, deer, ſheep, &c.

Man the moſt noble of animals, is a world inhabited by multitudes of inſects. The famous Borelli, an author who certainly is intitled to credit, affirms that he diſcovered in human blood animalcules of a figure ſimilar to that of whales, ſwimming in it, as in

in a red ſea. Other writers, equally learned and curious, mention larvæ found in the human brain, which proved fatal to ſome, tho' others were happily relieved from them. Inſects likewiſe find their way into the human ſtomach, whence they are expelled by means of emetics. Our inteſtines, are not more exempt from them than thoſe of other animals, as I had occaſion to mention above. Our whole body, ſo to ſpeak, is like a ſtorehouſe which furniſhes food to an infinite number of inſects. Some lodge between the ſkin and the fleſh where they live at our expence. Young children who are not kept clean, are chiefly expoſed to the attacks of vermin; and ſometimes it has become neceſſary to make inciſions in order to extract them from the noſe, the eye brows, the ears, and the tongues of many perſons. There are ſometimes animalcules under the ſkin of the hand, which creep along and make little elevations ſimilar to thoſe made in the earth by a mole. The Indians often have the leg and ſole of the foot attacked by long worms which cannot be extracted without the greateſt precaution. If they are broken, and the leaſt part remain in the limb or in the foot, the life of the perſon becomes endangered. There is alſo in the Indies a ſmall kind of flea called *nigua* (Pulex penetrans) which is likewiſe exceedingly troubleſome. It burrows between the nail and the fleſh of the toes, making them ſwell to ſuch a degree, that it is neceſſary to make an opening in them. One would think that the hardneſs of the bones would ſecure them from the inſults of theſe animalcules; and yet ſome are found living and feeding there. It is needleſs to mention thoſe that infeſt the external parts of our bodies, they are too well known. I ſhall therefore ſtop for a moment to conſider the wonderful diſcoveries made by Leewenhoeck in the ſemen of animals.

That illuſtrious obſerver of nature perceived with his microſcope an infinite number of ſmall animals ſwimming in the ſpermatic liquor. This diſcovery made him conjecture that the ſtrongeſt and moſt vigorous of theſe animalcules were arreſted in the matrix, where they were nouriſhed, and grew and became at laſt a perfect fœtus. What confirmed him the more in his opinion was, that in opening a female rabbit, immediately after its commerce with the male, he found in the matrix a vaſt number of theſe living animalcules. The obſervations he made on the ſemen of different perſons ſeemed to make the thing certain. In that of a boy, there was nothing ſeen but little black points without motion; while in that of a young man fully grown, there were myriads moving about with the greateſt activity. In that of old men ſome indeed were found, but they were without ſtrength or vigour and almoſt dead. Laſtly in people that were ſterile, theſe animals were not diſcovered, or if they were diſcovered, they were dead.

But he carried his obſervations further, and thought he could diſtinguiſh the different ſexes in theſe animalcules: whence he concluded that animals conceived males or females according as the different ſexes were detained in the matrix, where they were foſtered, and received enlargement.

Theſe animalcules are exceedingly ſmall, and Leewenhoeck ſays, that a drop like a grain of ſand contained many thouſands of them. He found them ſmaller than thoſe globules that give to blood its red colour, and he thinks that the place occupied by a grain of ſand, might contain an hundred thouſand. Their bodies are round, growing ſomewhat thick towards the head, and gradually diminiſhing towards the tail, which is five or ſix times longer, and about

five

five and twenty times more slender than the rest of the body; it is likewise transparent. They bend it a little, and move themselves like eels in water. There is a very great difference between the young of these animalcules, and those that are come to maturity. The first have the body more slender, the tail three times shorter, and less pointed than the latter. In the semen of a ram, those animalcules swam in a string one after another, as sheep do in water.

Many learned men have made the same observations after Leewenhoeck. In this number are Huygens, Andry, Valisnieri, Wolff and Tummig. Cartheuser shewed these animalcules some years ago at Halle in his lectures on experimental philosophy to more than sixty persons. Hartsoeker examined, during a course of thirty years the semen of a vast number of quadrupeds and birds. He compares the spermatic animalcules of the first to the tadpoles frequent in stagnant waters, which have not yet got feet; those of birds resemble small worms or a very slender thread. These observations made him suppose that there were only two kinds of spermatic animalcules to wit, those of quadrupeds, and those of birds. He did not deny that there might be diversities according to the different species, especially between those of man and quadrupeds; but he said that these were not discernible on account of their minuteness and the velocity of their motions.

The defenders of this doctrine disagree when they come to explain how these animalcules contribute to the generation of the particular species of animal which has produced them. Some with Leewenhoeck believe that in the intercourse of viviparous animals, one or more of these animalcules attach themselves, to the matrix, that others serve for their food, and

at laſt they become a perfect fœtus. They add that the ova in the ovarium, only produce the ſecretion of certain fluids. In oviparous animals the egg anſwers the end of the matrix, and to it the animalcule attaches itſelf. It penetrates into the middle of the yolk where it gradually grows to its perfection. Other authors diſſent from this ſyſtem, and maintain that, in copulation, one or more of theſe animalcules get up into the ovarium by the Fallopian tubes, and there penetrate into an egg, at that time in a proper ſtate to receive them, by means of an aperture furniſhed with a valve which prevents their retreat. In this egg it is nouriſhed and grows. Laſtly, ſome authors affirm that theſe animalcules have not yet the figure of a fœtus, and that they receive it by a transformation ſimilar to that of a caterpillar changing into a butterfly.

I ſhall not venture to decide on theſe various opinions, or to determine whether the animalcules are neceſſary to procure conception, whether they ſerve only to cauſe a voluptuous titilation, or if they are deſtined to any other uſe; ſtill leſs will I ſupport the opinion I have detailed. It appears to me too ſingular, and liable to too many difficulties, as various authors have ſhewn. It is certain, however, that theſe ſpermatic animalcules are worms of a particular kind, deſtined by the Creator to ſerve a particular purpoſe; but man has not yet diſcovered that deſtination, ſo great is the imperfection of human knowledge.

I had almoſt forgot to mention that inſects are found in the dry remains of plants and animals, as well as in works of art. There are ſome dry legumes which have the ſhell as hard as that of a nut: but this hardneſs does not ſecure them from the piercing teeth of ſome inſects which reduce them to powder.

Every

Every one knows that mites and maggots are found in cheeſe. They are ſeen in the ſkins of dead beaſts, and in their fleſh, where large flies lay their eggs, which afterwards change into an animal like that which laid them. Although inſects are not fond of fat or oily ſubſtances, they ſometimes however lodge in bacon, which hath loſt ſome of its fat by being ſmoaked. Laſtly, it is but too well known that moths lodge in cloth, in paper, and in books.

How admirable is the providence of God! He hath not only provided a habitation for man, but with infinite wiſdom hath likewiſe taken care to furniſh, for every ſpecies of animal he hath created, a ſuitable and appropriate place. They are all devoid of reaſon, and yet there is not one of them that is not endowed with a natural inſtinct which leads it to inhabit the places deſtined for it, where it finds the food which beſt agrees with it. Can we be ſurpriſed at this? He who has endowed them with this inſtinct is the ſame, "who hath 'planted the Cedars of Lebanon, where the 'birds make their neſts, who hath given the fir 'tree as an houſe for the ſtork, the high hills as a "refuge for the wild goats, and the rocks for the "conies.——Ps. CIV. 17,18. At his command "doth the eagle mount up and make her neſt on "high, ſhe dwelleth, and abideth on the rock, from "whence ſhe ſeeketh the prey; for her eyes behold "afar off." JOB. XXXIX. 27,29. "God doth "great things which we cannot comprehend, he "makes the beaſts go into dens, and remain in their "places." JOB. XXXVII. 5. 8.

What inference ought we to draw from this paternal care which providence hath taken to provide a habitation for all its creatures? It is very plain. If God hath provided with ſo much goodneſs for the wants

wants of the ſmalleſt inſect, and furniſhed it with a lodging convenient for it, ought we to fear that he will neglect or abandon us? Are we not of more value than theſe little creatures? Should it happen, that on account of our perſeverance in the faith we ſhould be expoſed to perſecution, and that thoſe who perſecute us, ſhould force us to fly from our country, our houſes and our homes, the Lord of the Univerſe will provide a place for us to retire to. Of this we have lately had an example in the perſons of the Saltzburghers. Theſe poor people, being driven from their habitations for the ſake of the goſpel, have not wandered hither and thither without knowing how to provide for themſelves. The Lord of heaven and earth made them find an aſylum in many places, even in the boſom of America. Different ſovereigns took pleaſure in affording a retreat to people whom their cruel country had expelled. Should the perſecution be ſo violent as to preſent no alternative between loſing life and renouncing the goſpel, let us not heſitate. Let us continue firm in the faith; perſuaded that our body alone will return to the duſt, but that our ſouls, redeemed with the precious blood of Jeſus Chriſt, will be received into thoſe everlaſting habitations which God hath prepared for the faithful after death. 'In my Father's houſe,' ſaith Jeſus 'Chriſt to his diſciples, 'are many manſions: had it 'not been ſo, I would have told you; I go to prepare a place for you; and when I am gone and 'have prepared a place for you, I will come again, 'and take you with me, that where I am, there you 'may be alſo.' JOHN XIV. 2,3.

May we not likewiſe infer, from what has been ſaid of the ſpermatic animals of which man is formed, and of that multitude of inſects which live on us both within and without, how ill it becomes us to be proud? A creature which perhaps derives its origin from an

an insect so small as not be discoverable by our senses, and which serves as food to such myriads of others, cannot be too humble or too sensible of its own wretchedness. Worms make as it were a part of ourselves; they enter our bodies with the first food we take, even in the womb, and from the common mother of all mankind, have perpetuated themselves continually from generation to generation. At our birth we are not delivered from them; the milk and other aliments we take are impregnated with them. They insinuate themselves into our bodies, which become for them a sort of moving house where they grow, and feed, and multiply. As God has made no new creation, these insects must undoubtedly have been formed at the beginning of the world; but I will not say that they were created to inhabit man. If they were, God has endowed them with the qualities necessary for living in our bodies without hurt to us, or inconvenience to themselves. The food destined for them is perhaps a superfluity, the abundance of which would be hurtful to man. At any rate, God does nothing without a reason; and if he meant that animals should live within us, we must believe that they are necessary for our welfare. This we are sure of, that they are so deeply rooted in our bodies that the species has been preserved there from the beginning of the world without perishing or being incommoded by the place they inhabit. Thus do wretched mortals carry in their bosom, millions of enemies ready to devour their bodies the moment the soul quits them. None are excepted from this general law, they no more respect the carcase of a lord, a prince or a king, than the lowest of the human race. Kings may defend themselves against the attacks of their enemies by opposing formidable armies; but can they resist those legions of insects! And who after this does not feel his own wretchedness? Who will not exclaim with one of the friends of Job? "The

"moon

"moon and the ſtars are not pure in the ſight of
"God; how then can he be clean that is born of a
"woman? man that is a worm, and the ſon of man
"that is but a worm?"——Job xxv. 4-6.

CHAP. X.

Of the Motions of Insects.

It is worthy of admiration that the faculty of motion is diverſified in as many different ways as it hath pleaſed God to create beings. The courſe of the Sun and the Moon, and Stars is fixed and invariable; the Sea has its motion of flux and reflux in a manner peculiar to itſelf; and all animals have in general one ſort of motion proper to their ſpecies and adapted to their wants. Some move in a ſtraight line; others like lizards proceed in a winding line. The motion of ſnails is very ſlow, they glide along almoſt imperceptibly by gluing their body to the ground on which they creep, by means of a ſlimy liquor they are abundantly provided with. Frogs move in a ſingular manner, and can leap to a great diſtance by means of their hind legs. The little green frogs called *Graiſſets* by the French, creep with eaſe along the moſt poliſhed ſurfaces, and find a ſort of ſteps where we can ſcarcely perceive the ſmalleſt roughneſs. The manner in which ſerpents advance is very remarkable; they have neither wings nor legs to help their

their motion; they move however at pleasure, sometimes quick, sometimes slow. The rings of the hinder part of their body contracting those of the fore part dart forward, and draw after them the rest of the body. What agility do not fishes discover in their various movements? They swim to every side with equal facility, darting sometimes upwards and sometimes downwards with the velocity of lightning. The wings of birds support them in the air in which they move in all directions and cleave it with the greatest rapidity. The mole, blind and without a guide, makes itself a road under ground. This vast variety, which is observable in the motions of different species of animals, has appeared so remarkable to many authors, that they have thought it worthy of their particular attention; but as they have not entered at large upon the motion of insects, I hope it will not be useless to take some notice of it here, and to impart my observations on the subject to the reader.

The motion of insects varies according to the element they inhabit. Those which live in water move in one way; and those which continue always on land in another. Besides, each species has a motion peculiar to itself. In the water some swim in a straight line, moving their head alternately to the right or left side, while their tail keeps a coresponding but opposite motion, and thus the animal always preserves the figure of the letter S. This is the case with the larvæ of the common gnat. Others swim from one side to another, advancing sometimes in a straight line, sometimes describing a circle or some other curve. Thus Swammerdam observed three different ways of swimming in the Monoculus Pulex, first in a right line like a fish; secondly, by an irregular motion like the flight of a sparrow, and thirdly by a sort of tumbling like some pigeons. Some spring in the

water from top to bottom, or from bottom to top, with prodigious velocity. The large Dytiſcus has under his wings an aperture garniſhed with hairs in which he retains a quantity of air. When he is at the bottom, he holds himſelf there with his feet, for when he loſes his hold, the air brings him inſtantly to the top. Some inſects move with extreme ſlowneſs, while others ſwim with ſuch velocity, that their members cannot be obſerved. Some, when they reſt, adhere to ſuch ſolid bodies as they find, or ſuſpend themſelves in the water; others walk on the ſurface of the water, or attach the caſes in which they live, to ſome piece of wood in order to prevent their falling to the bottom. The limbs of all theſe inſects are adapted to the motions they are deſtined to perform. Thoſe which are obliged to move thro' water, have an attenuated body which facilitates their progreſs in that element: others advance by means of their feet, or by a kind of fins made in the form of a plume of feathers. Although ſome are furniſhed with ſeveral of theſe members, and one might think that if one were taken away there would ſtill remain a ſufficient number, yet their motion then appears evidently retarded, and they execute with difficulty, what before they performed with the greateſt eaſe. So true it is that the Creator has beſtowed nothing ſuperfluous, nor given them any thing but what is abſolutely neceſſary.

We find on the earth certain inſects which like ſerpents have neither feet nor wings, and which yet move with eaſe. They go from one place to another with a ſerpentine motion which is performed by the muſcles of their rings; theſe contract, and making the inſect ſhorter, give it the power, by dilating thoſe of the forepart of the body, to advance. Such a motion may be diſtinctly ſeen in the common earthworm. Others bend themſelves, and advance by a ſpring,

ſpring, as maggots do in cheeſe. They draw their tail towards the head, and then ſuddenly extending themſelves, like a bow after the arrow is let fly, bound forward more than their own length. This motion which can be attributed only to the elaſticity of their bodies is remarkable, and ſerves them inſtead of legs and muſcles, by means of which other inſects leap.

Thoſe with feet do not all move in the ſame way. Some go forward in a ſtraight line, and others bend their back; ſuch are the caterpillars called *Geometræ*. In general theſe have but two intermediate feet. When they go from one place to another, they extend their body as far as poſſible, and take hold by their ſix fore feet; then they draw up to theſe feet the poſterior part of the body, which is then bent like a bow. Fixing themſelves then by their intermediate and poſterior feet, they extend themſelves anew, and thus make a ſtep almoſt as long as their body. Their motion is like that of a perſon's hand, when he is meaſuring any thing by a ſpan. Some inſects move ſideways like the ſmall winged inſects that infeſt horſes. Others turn round in a circle, and others move only by leaps for which they are fitted, by having long legs and muſcular thighs. Some march with inconceivable velocity. M. Deliſle obſerved a fly almoſt inviſible from its minuteneſs, which run over three inches ſpace in half a ſecond, making in that time five hundred and forty ſteps. Other inſects move exceeding ſlowly. Many of thoſe whoſe bodies are long help themſelves by means of their hinder part, which they fold under them, and then make uſe of it to puſh themſelves forward. Some extend themſelves at full length when they go to reſt, and others are rolled up in the manner of ſerpents when they ſleep.

As there are insects which are obliged to seek their food in different places, and sometimes at a distance, God hath wisely provided them with wings to facilitate their frequent excursions; but that they might be able to maintain their bodies in a perfect equilibrium, the Creator has given to some four wings, to others little balancers, (halteres.) These are little balls placed under the posterior part of the wings on both sides, and are connected with the body by very slender filaments, which enable the insect to move them when it has occasion. In some they are naked, in others covered. They answer the same end to insects, as the pole does to rope dancers. If one of these balls is cut off, the insect inclines to one side; if both are taken away, it no longer has that light and equal motion it had before, it cannot direct its flight, but turns topsy turvy. Most insects wanting the tail of feathers which birds have, do not take so equal a flight, nor preserve so just an equilibrium in an element so subtile and so yielding. There is a species of Butterfly which is excepted from this general rule. It is furnished with a tail by means of which it directs its flight at pleasure. There is even a difference in the flight of the male and female, that of the former being most rapid. The reason of this no doubt is, that the females being laden with eggs, are heavier than the males, and consequently their flight is not only slower, but shorter. Might not nature mean by this to teach us, that it is the duty of women not to wander far from home. A difference of velocity in their flight is perceived also in the different species. Lastly some mount aloft into the air, while others continually hover near the surface of the earth.

These motions of insects cannot but elevate our thoughts towards the Creator. The faculty of motion is not an essential property of the matter they are composed of. We see evidently that a body purely

ly material cannot put itſelf in motion, nor can quit its place without being impelled by ſome other body. But inſects move hither and thither in a thouſand various ways. Whence do they derive this faculty? They do not receive it ſurely from their body, which being purely material, has not the power of motion of itſelf. But it will be ſaid it is the ſoul of theſe inſects which is the cauſe of their motions. Be it ſo; but I aſk is that ſoul material or immaterial? If the materiality of the ſoul is maintained, the ſame difficulty will recur, and I ſhall then aſk how comes this material ſoul to have the power of moving itſelf, while every other ſort of matter remains at reſt, except when put in motion by ſome other body? Who hath beſtowed on it a property ſo different from any we ſee inherent in other matter? If it is ſaid that this ſoul is immaterial like that of a man, ſhall we be nearer our purpoſe? I think not, till it is explained to me how a ſubſtance purely ſpiritual, can act on matter, and put it in motion. This difficulty is as great as the former, and neither of them can be ſolved without having recourſe to a firſt mover whoſe power is unbounded. Of this he hath given deciſive evidence by endowing animals with the faculty of motion. This proof of his power is ſo great that we cannot comprehend it.

He hath not only given to the motion of animals its firſt impulſe; but he ſtill continues to preſerve to them the daily uſe of it. This truth was one of thoſe which St Paul remarked to the philoſophers of Athens, when he announced to them the Goſpel. "In God we live, ſays he, and move and have our "being." ACTS xvii. 28. We ſee alſo that when ſpeaking by the mouths of his Prophets, God exhibits himſelf as author of the motion of the Sea. "I "am the Lord thy God, which divideth the ſea,

"when

"when the waves thereof roar; the Lord of hosts
"is his name." ISAIAH LI. 15.

The first impulse of motion in created beings and its preservation is not the only thing remarkable on this head; there is another which deserves our most serious attention. Every thing in nature is in motion. Some of the bodies which compose the universe, have a constant motion from which they never depart, while that of others is arbitrary and varied. How comes it that so many different motions all opposite to one another, do not derange the economy of the universe? The most simple and best constructed clock-work often goes wrong, and lasts but for a short time. But the universe has endured for ages without the smallest change. And what wide difference is there not between a piece of clock-work, I will not say the most simple, but the most complicated, and the machine of the universe! From whom flows a regularity so wonderful? What cause preserves in so perfect an equilibrium so many contrary forces which would seem mutually to counteract and destroy each other? It is God alone, whose power is unbounded, and whose wisdom is unsearchable. He presides over all those various motions; he preserves and directs them, and prevents them from interfering to their mutual destruction.

How many motives do not these considerations furnish us with for adoring and magnifying the Creator! He is the author and preserver of this perpetual and universal motion, without which we could not exist. What gratitude does not such goodness deserve? Let us reflect with attention on the advantages, and on the infinite pleasures which result from those motions which God hath communicated to animals; let us for this purpose suppose that we were totally deprived of them and we

we shall then be sensible of the full value of the benefit we derive from the hand of the Creator. The free motion of each of our own members, is still more necessary to us; the loss we would sustain of them would be irreparable. What obligations then have we not to God who hath bestowed on us the power of moving them, and who preserves to us that power! In truth, the man must be very ungrateful and very unworthy of so great a blessing, who does not employ so excellent a faculty to the glory of God by every exertion in his power.

CHAP. XI.

OF THE FOOD OF INSECTS.

THE subject of the last Chapter presented an excellent opportunity of displaying the infinite power of the Creator; the present will open a vast field for reflection on his bounty and wise providence in the care he hath taken to furnish abundance of proper food for insects. All living creatures are under a necessity of taking nourishment for the preservation of life. Insects are not excepted from this general rule. It is true that there are many which can live longer without food than other animals; but they cannot exist without it altogether. The reason why some insects can fast for a long time, perhaps for a month or two, is that their humours being thicker their animal

mal spirits are not so soon or so easily dissipated. They all dread the rigour of winter, and to shelter themselves from it they retire into warm places; there are however but few which lay up provisions to supply them during that season. The bodies of those that do not eat are of a particular contexture, especially as to what regards the circulation of the blood and humours. They are so framed as to lose nothing by transpiration, and consequently do not require food to repair their waste. They retire into resting places where they continue in a state between life and death, till the heat of the sun acquires power to reanimate them, and to give birth to those substances on which they live. It is neither wind nor rain which makes them seek those retreats in which they reside without eating. Thus a state of repose seems as natural to them as rest and sleep to the other animals. Towards the end of Summer, and even before the cold weather sets in, they are seen assembling in crowds like Swallows, and preparing for their winter repose.

A great diversity is remarkable in the tastes of insects. What is agreeable to one, disgusts another, and some eat with avidity, what others will not touch. There are also some which are not always content with the same food. Like gluttons who devour every thing, these insects sometimes take one sort of food sometimes another. Some too from necessity will eat what they do not relish, and which they do not generally feed on; but then they are so circumstanced that they must either eat or die. All are not so accomodating however as these; for a great number use but one sort of food, and will rather die than taste another.

What was observed in the Chapter on the habitations of insects may at once shew how many things they

they use as aliment; for they never fail to lodge in places where their food is within their reach. Dust; moist or dry earth, sand, the hardest stones, and even iron itself, furnish them with provision.

But plants are their most common food. Some brouse on the green blade, others gnaw the roots and stems. Some pierce the wood and feed on its fragments; others are not satisfied but with the tender buds. Some caterpillars devour the leaves of trees and herbs, while others attack the very pith of the plant.

They do not betake themselves solely to those plants that are wholesome or of an agreable taste, but some insects prefer even such as are insipid and venomous. The wormwood, bitter as it is, feeds the caterpillar of the Phalæna Absynthii, and this instance would be sufficient to refute the opinion of some authors who have asserted that insects feed only on mild vegetables; but there are other examples. The Spurge, notwithstanding its' acrid and noxious qualities, is preyed upon by the Sphinx Euphorbiæ and the Phalæna castrensis.

Among the insects that eat the leaves, some touch only the upper surface, others only the under: others devour both, leaving nothing of the leaf but its fibres, the skeleton of which resembles a sieve. Many are so delicate that they will be content with nothing but the tender flowers. Others attack only fruits and grain; and are often found in the pods of peas, in pears, apples, plumbs, &c. Corn, bread, cheese, sugar, and even books are preyed upon by different species, and many valuable manuscripts have fallen a sacrifice to their voracity. The moth destroys woolen stuffs, as is but too well known.

The sacred writers often borrow comparisons from this little animal. Job, describing the wretched condition he was reduced to says, "that he consumed as "a rotten thing, as a garment that is moth eaten."— Job xiii. 28. Among the threatnings which God made to the enemies of the faithful, the following is not one of the least terrible. "Ye people in whose "heart is my law, fear ye not the reproach of men, "for the moth shall eat them up like a garment, and "the worm shall eat them like wool." Isa. li. 7,8. "See, (says Baruch,) the purple which shines on the "statues of false Gods. But it shall lose its lustre "and fade, and they themselves shall at last be de- "voured by worms." Ch. vi. 70. "Ye rich, says St "James, weep for the miseries that shall come upon "you. Your riches are corrupted, and your gar- "ments moth-eaten. Ch. v. 1,2.

Insects prey upon one another. The Scolopendræ which live in dunghills, feed on a species of small worm which also lives there. The tree bugs insert their rostrum into the body of a downy caterpillar with yellow spots which is found on willows towards the end of the season, and suck its blood. There is a species of exotic ant which lives on spiders, and these in their turn feed on flies, and sometimes on ants. We likewise find flies that devour one another, and even the moth of the Silk-worm. The ichneumons kill spiders, and afterwards carry them to their nests. One species of Dragon-fly, (the Libellula puella) contributes very much to rid the atmosphere of flies and butterflies. Between it and the common cabbage butterfly a chace commences which resembles that of the hawk and the heron. The dragon fly seizes the Papilio in its flight, and holding it firm with his fore legs, devours it entirely. Some beetles feed on the aphides. I have mentioned already the lice that adhere to serpents and birds. I shall only add

add here, that some spiders eat the eggs of these last, and others devour their young.

It is well known that the flesh of dead animals serves for food to many insects, and that even human flesh is not secure from their attacks. It was this consideration which made Job say, that 'man is crushed 'sooner than the moth.' CHAP. iv. 19. and in another place, "The grave is mine house; I have made "my bed in the darkness. I have said to corruption thou art my father, and to the worm, thou "art my mother and my sister." CH. xvii. 13. 14. The same lot awaits us all. "One dieth in his full "strength, being wholly at ease and quiet. His "breasts are full of milk and his bones moistened "with marrow; another dieth in the bitterness of "his soul, and never eateth with pleasure, but they "lie down alike in the dust, and the worms cover "them." JOB xxi. 23,26. "Shall dust, says the "son of Sirach be proud? He who is a king to "day, shall be dead to morrow, and when a man dies "he becomes the property of serpents, of beasts, and "worms." ECCL. x. 12,13.

There are certain insects which have no other nourishment than the fluids which they suck. For this purpose nature hath furnished them with a kind of siphon through which they pump up the liquor that sustains them. Some content themselves with pure water; but others whose taste is more refined will put up with nothing but wine. Some are satisfied with the juices of the leaves of all sort of plants, while others of a sanguinary disposition live solely on blood, and therefore attack both man and beasts. Some eat as well as drink, as do all the tribe of grasshoppers.

As insects cannot accommodate themselves to every sort of aliment, they could not have existed had not their

their Creator provided them with the sagacity necessary to enable them to procure for themselves that particular food which is fit for them. And indeed nothing can be added to the exquisite workmanship of those organs with which they are endowed for this purpose, or to the instinct which leads them to their prey. They find it as certainly as a lamb finds its mother, a hound the tract of the animal it pursues, or a calf the dug of the cow which gives it suck. The eyes of some are so constructed that they can discover their food on all sides, and even at a distance. Others have the sense of smelling so perfect, that it guides them to their food though considerably remote. Some which live in water adhere to solid bodies, and are able by agitating the fluid around them to bring the bodies that float in it within their reach.

The time they consume in feeding, differs in season and duration. Some eat only during the day, and repose at night, others pursue a quite contrary conduct. The Phalænæ for example continue at rest during the day, in some obscure place, because they are made almost blind by excess of light; but on the approach of evening, they fly in search of food. By this a double purpose is served. First, they do not commit such ravages as they would do, were they to feed both day and night; and secondly, those which fly by night are not exposed to the voracity of other insects which appear only in the day.

I must not omit the various artifices employed by insects in seizing their prey. Like other animals they have received from their Creator that sagacity and address which their way of life requires. Some like the Lion pismire, (Myrmeleon Formicarum) having concealed themselves, watch for their prey like a lion in his den, till finding it within their reach, they spring upon it with amazing velocity. Some continue motionless

tionless as if they were dead; and when the animal approaches they are lying in wait for, they seize him when he least suspects danger. Some encompass him with a web that he may not escape, while others grasp him so firmly with their feet, that he cannot disengage himself.

The manner in which some kill the animal they have had the address to take, is not less worthy of our curiosity. They practice as many stratagems as a man would make use of, to kill a dangerous beast of prey.

Those insects which have occasion for food during winter are endowed with a particular instinct. We see them laying up their stores. In the course of the proper season they carry these stores to a convenient place and secure them as in a granary. In this class bees and ants are to be ranked. The former make an abundant provision of honey to supply them during the rigours of winter. The latter lay up grain and other substances of that sort with which their subterraneous abodes are filled. The industry of the ant and its labours are so great, that the wise Solomon proposed it as the best example for imitation to the slothful: "Go to the ant thou Sluggard, says he, consider "her ways, and be wise; which having no guide, "overseer or ruler, provideth her meat in the sum- "mer, and gathereth her food in the harvest." Prov. Ch. vi. 6,7,8; and in another place, "The ants "are a people not strong, yet they prepare their "meat in the summer." Chap. xxx. 25.

The food necessary for insects is always in sufficient plenty, to secure them against famine. The proportion between insects and the substances they feed on is so well preserved that wherever they are numerous, there is also a great quantity of their proper food and in places where that food is wanting, there

there are but few insects. Herbs and plants constitute the most common aliment not only of insects, but of other animals and of man himself. The prodigious consumption of these, which takes place annually, would have considerably encreased our toil, had much pains been necessary to cultivate vegetables: but Providence, ever wise, has taken such care for the spontaneous growth of many plants that we may say the tables of herbivorous creatures are always abundantly supplied. But as the rigours of winter destroy the verdure of the fields, which only revives when the heat of the Sun begins to cherish the earth, Insects sleep when their food is withdrawn. Besides, they do not issue from their eggs or their cones, till their destined food is prepared. And as in a mild season their strength is exhausted and they are awakened by perspiration, they would soon perish were they prevented by famine from repairing the waste they undergo. But the abundance of their food supplies their loss of strength; every day furnishes enough to maintain them in life and vigour, and they convert into their own substance the nourishment they take in. They bruise and render it fluid; it is afterwards digested and subtilized that it may pass through such a multitude of minute vessels, fill their limbs, and communicate to them new strength. Indeed some of these animals are content with very little nourishment.

The organs with which God has endowed insects for taking in their aliment deserve our attention. Those that eat have claws for seizing their food, and teeth for gnawing and comminuting it. In some these are so sharp and so strong that they easily break to pieces the hardest substances. Those which live only on the fluids which they suck, have received from the author of their being a sort of pump, longer or shorter according to their necessities, for the purpose

pose of extracting the fluids they have occasion for. Some are very temperate, and do but little mischief; the caterpillar of the Phalæna quercifolia, though four inches in length, and more than half an inch thick, eats nothing during the day, and in the course of a whole night, does not consume more than two leaves of the pear or plumb tree. Others are real epicures which seem born to be gluttons. Some of these eat so voraciously, that they seem to be in dread lest their food be taken away from them. Those that drink generally touch the liquor with the extremity of their antennæ; which seems to be their method of trying whether it is fit for them. Some for this purpose use the extremity of their rostrum, and sip the liquor, drop by drop; others drink by means of the syphon I have already mentioned. Some also are real drunkards, and are obliged to disgorge what they are not able to contain: some likewise die when they cannot find the liquor they relish.

The facts contained in this Chapter demonstrate the great and incomprehensible wisdom of the Creator. It is certain that insects are devoid of reason; yet their whole economy seems to be the result of sound judgement. We may say that they foresee the future, since they make provision against its wants. What would become of them when winter has destroyed all the substances that furnished them with food during the summer, were they not wise enough to lay up a store for their maintenance in that severe season? When there is no verdure on the fields, when every tree and plant are stript of their leaves, and no fruit is left to supply their necessities, are they destined to perish with hunger and famine? By no means. Providence has taken care to supply them. Those who live only on vegetables, are so formed as to dispense with food altogether at that season. Others are led by instinct to hoard up, in the summer, the food

they

they will need in the winter. That foresight is the effect of a wisdom which certainly they do not possess. Whence then do they derive it? The answer is easy: They have it from the author of nature, the giver of every good and perfect gift.

The diversity of their tastes which leads them to prefer certain aliments to others is likewise an effect of the infinite wisdom of God. If all fed on the same thing there would not be enough in the world for their sustenance, and they would die of famine; their species could not be preserved, and man would not be able to make any use of that which was not destined for their food. But, by the wise dispensation of the Creator, all insects have abundance of nutriment, and enough remains for other animals.

The things which they feed on would have been created in vain, had they not been endowed with the organs necessary to convert them to their own use. Whence do they acquire that sagacity which makes them discover at a distance the things that are proper for them? How have they procured that acuteness of sight, or that delicacy of smell and taste which prevents them from erring in the choice of their food? Of whom have they learnt those stratagems and artifices which they put in practice in order to seize their prey, and devour it? What artist hath executed with so much precision, and in a manner adapted so much to their destination, the organs which serve them for eating and drinking? How happens it that they do not all require the same quantity of food? What wise being hath regulated the difference between them in this respect, so that they shall eat or drink more or less in proportion to the facility with which they are able to procure the things they want? The man must be infatuated who could attribute all these circumstances to blind chance. Such marks of design and

a plan so wise, are so evidently discernible, that one must shut one's eyes against the light not to acknowledge in the whole the hand of a God all wise, and almighty.

If we consult the Scriptures they will fully confirm this truth. "The Lord says the Psalmist, causeth grass to grow for the cattle, and herbs for the service of man. All creatures wait upon thee, that thou mayest give them their meat in due season. What thou givest them they gather: thou openest thine hand, and they are filled with good. Thou hidest thy face; they are troubled; thou takest away their breath, they die and return to their dust. Thou sendest forth thy spirit, they are created, and thou renewest the face of the earth." Ps. civ. 14,27,30. And in another place, "The eyes of all wait upon thee, and thou givest them their food in due season. Thou openest thine hand, and satisfiest the desire of every living thing." Ps. cxlv. 15,16.

The care which God takes of insects carries with it so many distinct marks of paternal solicitude as ought to induce mankind to place their confidence in his bounty. If we have not always every thing that it is necessary for us, and if even common resources fail us, we ought not to lose all hope. The wise ruler of the world, who feeds with such abundance all those animals, will not forsake us his rational offspring. This sovereign monarch of the universe, who provides for the necessities of the meanest of his creatures, who leaves not destitute the smallest worm, will he allow to perish with hunger, the beings he hath designed to call his children? This reasoning is not mine, it is that of the Saviour of the world himself. "Behold the fowls of heaven, said he to his disciples, they sow not, neither do they reap, nor

" gather into barns, and yet your heavenly father " feedeth them. Are ye not much better than they?" Mat. vi. 26.—It is our duty then, that our trust in him may not be vain, to conduct ourselves so that we may gain the favour aad protection of the supreme being. His blessings will then be renewed to us every morning; for the Lord will never forsake those who put their trust in him.

CHAP. XII.

Of the arms with which Insects defend themselves against their enemies; and of the means they employ for avoiding other dangers.

In this Chapter I propose to treat not only of the sagacity of insects in guarding aginst danger; but of the organs with which divine Providence hath furnished them, both for securing themselves against the inclemency of the seasons, and for escaping the pursuits of their enemies. Galen, long ago, made the following judicious remarks upon this subject: " The body of all animals, says that great man, is always proportioned to the faculties and inclinations of the mind. The horse, that active, fierce, and noble animal has the hoofs of his feet hard and strong, and his neck is adorned with a mane, which contributes

contributes not a little to give him that majestic air which we so much admire in him. The teeth and claws of the Lion correspond exactly to his natural disposition, which is daring and sanguinary. The same may be said of the horns of the bull, and the tusks of the boar. Timid animals such as the stag and the hare, have only for their defence the swiftness of their feet."

This reflection may be justly applied to insects: God has not been at less pains to provide for their safety, than for that of other animals. Some are endowed with such velocity as to escape danger by the suddenness of their flight. Some creep with a good deal of speed, but others fly most rapidly; others allow themselves to drop from the place of their ordinary abode upon being disturbed. Those which cannot move with the same facility, make use of address. Some not being able to change their colour like the Camelion, choose for their abode, places of the same colour as their bodies, that their enemies may not be able easily to discover them. Others wrap themselves up like a hedge-hog to put in safety their heads, and the more delicate parts of of their body. Some seem willing to intimidate their enemies by an appearance of anger which they testify by a violent motion of the head: and lastly, some when they are touched, discharge a fetid liquor which disgusts their enemy, and forces him to retire.

But the goodness of the Creator does not rest here. Many of them, have arms for their defence. The skin of some is hard enough to secure them from ordinary injuries; the teeth of others are exceedingly formidable. Some are invested with fine and sharp hairs which oblige their enemies to quit them, from the piercing pain these darts occasion. Others

have horns with which they seize and crush their aggressors. Some have stings that pierce the hardest substances; and others putting the anterior part of their body into holes, leave the other exposed which serves to defend them by the sharp points or pincers, with which it is armed.

All these are so many visible marks of the wise and provident care, which God hath had of these despised animals. It appeared so great to some philosophers, that they imagined nature had been more kind to them than to man, and that she acted as a step-mother to him, by denying him those weapons of defence she hath bestowed on other animals. The consequence however does not follow from the premises. Reason, which God hath given to man, is of more use to his preservation, than all the means of defence he hath given to other creatures. He is capable of fabricating arms to himself for resisting the most ferocious and best armed animals: he can invent the means of taming the most savage, and those that seem the most ungovernable. But without enlarging further on this circumstance let us state the answer which Galen gave to the same objection. "Nature, says he, hath given hands to "man. Directed by his sagacity they are the in-"strument by which he executes whatever he finds "necessary either for peace or war. He therefore "had no use for horns; his hands can form a "sword or a lance which are weapons much longer "and more destructive than horns. The feet, the "claws and horns are of no use at a distance; but "the arms of man's invention can annoy at a dis-"tance as well as near. Would the horns of a bull "be as useful to a man, as bows and arrows? We "can not only procure arms for ourselves by our "own industry, but we can wrap ourselves up in a "coat of mail, which renders us more invulnerable

"than

"than the hardest skin. Besides cannot man build "himself a house, raise walls around him, enclose "himself in a tower &c.?"

This reflection of Galen's shews that God has not been less attentive to the safety of man than to that of other animals. Exposed to so many dangers, naked and destitute of every sort of defence, what would have become of us had not the Creator endowed us with reason, a gift so precious, that it serves us instead of all the arms bestowed on other animals. We must not imagine however that even with this we are in a condition to resist all our enemies; they are in too great numbers, and are incessantly laying snares for our body and our soul. In this case we should be miserable indeed, did God forsake us; but will he do so? Will he who leaves not without defence the vilest worm, will he suffer man to become the prey of his cruel adversaries? Assuredly not. He is too beneficent, and has given us too many marks of his kindness to allow us to entertain such a thought. Let us then cry out boldly with David, the Lord is a refuge in time of trouble for the oppressed. Ps. xi. 9. This that holy man had often experienced, and accordingly he says in another place, "the Lord has been my defence, "and the rock of my refuge." Ps. xciv. 22.—— Let us therefore rely more on the powerful assistance of our Creator than on our own strength, being assured that our trust shall not be in vain. "The eyes "of the Lord." says the wise son of Sirach "are on "those who love him; he is their mighty protection "and strong stay, a defence from heat, and a cover "from the Sun at noon, a preservation from stumb- "ling, and an help from follies. He raiseth up the "soul, and lighteneth the eyes; he giveth health, life "and blessing."

CHAP. XIII.

OF THE CARE WHICH INSECTS TAKE OF THEIR EGGS, AND THEIR YOUNG.

THE natural inſtinct which determines the inſect race to take care of their eggs and of their young is ſo remarkable, that I think proper to treat of it, in a Chapter apart. They are neither hatched like birds; nor ſuckled like quadrupeds. The Sun alone by its heat brings them forth, and no ſooner do they quit the ſhell, than they are in a capacity to chuſe food and to eat it. The whole foreſight of the mother is confined to the depoſiting of her eggs in places where the heat of the Sun may eaſily reach them, and where the young may at once find the food that is convenient for them; at leaſt till they are in a condition to go in queſt of it themſelves. It is for this purpoſe they are ſeen chooſing the places where their eggs may be protected from the inclemency of the weather. Some depoſit in theſe places the things neceſſary for their young; and ſome carry them from one place to another, when they find them expoſed to accidents.

The choice which inſects make of the places in which they depoſit their eggs, is as remarkable as the diverſities in their manner of liſe. Each chuſes for that end the ſubſtance which is the proper food of the

the young insect. Such as live in the water lay their eggs in that element; but as there is a great difference in the quality of water, each chuses that which is most suited to its nature. Some deposit their eggs in pure water, as gnats; others in stagnant pools, as the Tipula phalænoides, &c. while others prefer fluids composed by art, such as beer, &c. Some deposit them under the surface of the earth, where they are defended from the injuries both of heat and cold. Some which live on plants and fruits, deposite theirs either within these, or on their surface. Hence we find them on the stalk, and on the leaves of plants, sometimes on the trunks of trees, and under the bark, where they are defended from the heat of the Sun, and from rain: they are found also both in dry and green wood. Those which require a greater degree of heat to bring them forth or which feed on the fluids of other animals, lay their eggs on the body, and even within it, of those which are their proper food. For this reason we find them in other insects, under the scales of fishes, and in their flesh, on the feathers of birds, among the hairs of quadrupeds, in the nostrils, and in the flesh of animals.

In chusing a place, they are much determined by its furnishing them with food. Almost all of them chuse a situation in which their young will not be incommoded by bad weather; but besides this, some fix their eggs with a sort of gluten, which retains them, and prevents their being washed off by the rain. This glutinous matter sometimes becomes so hard, that no external force can penetrate to the eggs and break them. Others, to shun the cold, cover them with the hairs of their own body, or weave a web around them, and wrap them up as in a cloak. If any happen to deposit their eggs in places where the young cannot find food, they provide it them-

selves

selves, that nothing may be wanting after their exclusion. Many sorts of ichneumons kill caterpillars and carry them to their nests where they keep them with great care, that they may serve for food to their young when hatched. The care of their brood with some is carried to such a length that they carry their eggs always about with them, or at least, in case of danger, transport them from one place to another. Lastly, some after having deposited their eggs in safe places, defend them by various ways from the injuries of their enemies.

The instinct which leads them to use so many precautions, must proceed either from the animal itself, or from some other being eudowed with reason and intelligence. It cannot come from the animal itself, which being devoid of the faculty of reason, is incapable of that foresight and wisdom, of which all these cares are the result. Who then is the Being that directs them to make use of all those astonishing precautions which I have detailed? The answer is easy. We know of no being but God who is capable of it. It is he who hath taught them to lay their eggs in places the most proper for their convenient and safe exclusion: it is he who among so many situations equally proper, teaches them to choose that where the young will find, at issuing from the egg, the food most convenient for them. Indeed who else but he could inspire them with such affectionate solicitude? Who could teach them to provide sustenance to their young when the eggs are deposited in places where it is not to be found? From whom have they learnt that prudent practice of removing their eggs from a place where they are exposed to danger? To whom can such wonderful effects be attributed, if not to the Creator and Preserver of all things, whose goodness is equal to his power and his infinite wisdom?

It

It is not among infects alone, that this parental care is to be feen. Quadrupeds are poffeffed of it in an equal degree. The ferocious lion, and implacable tyger, the ravenous wolf, and voracious dog, the venomous ferpent, and cruel dragon, love their young, provide for their neceffities, and never hurt them. The prophet Jeremiah feems to allude to this, when he fays that " the fea-monfters draw " out the breaft; and give fuck to their young ones." LAMENT. iv. 3. Man is endowed with this inftinct like animals. It is on this affection for our childdren that St Paul founds his argument when he fays " that no man ever yet hated his own flefh, but " nourifheth and cherifheth it." EPH. v. 29.——" Can a woman forget her fucking child, fays Ifaiah, " and not have compaffion on the fon of her womb?" CH. XLIX. 15.

However natural this inftinct may appear, yet there are perfons to be found who feem to have loft it entirely. They deprive their children of neceffaries, and cruelly ufe them, and take no care either of their foul or their body. This is not all: there are women who, that there may be no living witnefs of their iniquity, pitilefsly expofe the fruit of their womb, without caring whether they perifh for want, are devoured by beafts, or are carried off by perfons charitable enough to do fo. There are even fome, (can it be conceived without horror!) who are barbarous enough to imbrue their hands in the blood of their little innocents, formed in their womb, and nourifhed with their blood! The moft ravenous beaft is incapable of fuch cruelty: nor is there any thing fimilar to be feen among infects, the vileft of creatures.

CHAP. XIV.

OF THE SAGACITY OF INSECTS.

THAT man ſhould diſplay wiſdom in his economy is not ſurpriſing. God hath endowed him with a rational ſoul, by the aſſiſtance of which he thinks, judges, reaſons, and is induced to conduct himſelf agreeably to the inductions which flow from his juſt principles: but that animals deprived of the uſe of reaſon, and all inſects, ſhould exhibit ſo much of it in their whole economy is what ſurpaſſes our comprehenſion. I have already remarked a vaſt number of inſtances of this kind which authorize us to conclude that inſects act according to the rules of wiſdom; but as the ſubject is exceedingly intereſting, I ſhall collect in this Chapter, the principal proofs of their ſagacity.

The ſkill of birds in conſtructing their neſts is ſo great, that the moſt ingenious artiſt could not exceed it. With what neatneſs do they not combine pieces of wood, and ſtraw, and moſs and clay together, in the formation of their neſts! What art is conſpicuous in the arrangement and diſpoſition of each of the parts which compoſe them? What precautions to defend them and their young from cold! The inſide of the neſt is always lined with hair, with

with feathers, or wool, which are difpofed with such neatnefs, that every particle contributes to keep the neft warm, without in the leaft hurting the eggs or the young. That their nefts may not be expofed to view, they are generally built in fecret places; and the bird takes fo many precautions to conceal them, that it is with difficulty they are difcovered. In general they all endeavour to fkreen them from danger, and from the injuries of the weather. Laftly, there are fome exotic birds that interweave the flender fibrous parts of plants with fo much dexterity, that they conftruct a round and hollow neft, which they afterwards fufpend from the fmall branches of trees, to put them out of the reach of their natural enemies.

The fame fubtilty is obfervable among infects. They are fmall and weak; but they appear great and able labourers in the formation of their nefts. For this purpofe they collect and ufe all forts of fubftances. Some make fmall round cafes of earth, like the nefts of fwallows, others form them very dextroufly of ftraw or grafs. Some roll up the leaves of plants, in order to lay their eggs in them, but with fo much art, that we cannot help being ftruck with aftonifhment at it.' They have various ways of rolling up the leaves, but they are all wonderful. Some ufe but one leaf, others feveral. Some roll the leaf from the point to the bafe, perpendicularly to the principal nerve; or fideways parallel to that nerve. Thefe laft take care to roll their leaf in fuch a manner that from one extremity to the other, each fold of the roll is parallel to the fide of the leaf, while others roll it up like a horn, with one of the ends fmaller than the other. Some only double the edge of the leaf longitudinally, making a fort of hollow hem; or if they flope much, the fold is unequal. When they roll up a part of the leaf, they

fix the roll in the ſhape they want it by means of different parcels of threads very artificially ranged and attached on one ſide to the top of the roil, and on the other to the ſurface of the leaf on which it reſts. It is nearly the ſame when they roll up whole leaves. Each circumvolution is connected with that which follows it, by threads diſpoſed like thoſe in the former inſtance.

There is likewiſe great variety in the methods uſed by thoſe that live in ſociety. They employ ſeveral leaves to ſerve them for a common dwelling. Some make them round like a pear, obſerving to make ſeveral holes for gates. Others join theſe leaves together, ſo that externally they have the appearance of an inverted cone, or nearly ſo. Among thoſe that live ſolitary in a habitation compoſed of ſeveral leaves; ſome conſtruct it of leaves ſeparately rolled up longitudinally, and placed contiguous to one another; others make a kind of tube formed of different leaves, wound up ſpirally.

There are inſects which though they do not roll up the leaves, yet contrive to make a habitation of them. Some take two which they ſo cloſely connect together with their threads, that the under one ſerves them for a bed, the upper for a covering. They are ſo firmly attached to each other, that neither wind nor any other ordinary accident can ſeparate them. Others grind the leaves and reduce them to powder, which they afterwards mix with a viſcid liquor iſſuing out of their bodies; and of this mixture they frame their houſe. Some, inſtead of pulveriſing the leaves, gnaw the wood, and uſe the comminuted particles in the ſame way. Some, in order to poliſh and give a certain conſiſtence to their neſts, uſe the reſin of trees and ſhrubs; others form round their eggs a kind of tent with the threads they draw

draw from their bodies. In general every different ſpecies ſhows great dexterity in collecting materials for nidification. To ſee them carrying what they have ſelected for this purpoſe, one would ſay that they had received leſſons, and that ſome ingenious mechanic had taught them the ſimpleſt and moſt convenient method of conveying theſe materials and uſing them.

The ſtructure of different neſts is not leſs demonſtrative of the addreſs of theſe inſects, than the precautions they uſe in placing them indicates their foreſight, I ſhould compoſe a large volume, were I to enter into a compleat detail upon this head. I muſt therefore confine myſelf to a few examples of thoſe which appear to me the moſt ſingular, I ſhall begin with the ſtructure of the combs of Bees.

Theſe inſects begin their labours by fixing the comb to the firmeſt part at the top of the hive, and continue it downwards, and on both ſides : and to attach it with the greater firmneſs, they ſometimes employ a kind of wax or glue. It cannot be ſaid with accuracy, in what manner Bees perform this part of their work. They are in ſuch numbers, and in ſuch conſtant motion, that to the eye, every thing appears confuſion. The following circumſtances are however obſervable. Theſe little creatures are ſeen carrying to the places where they are at work, little bits of wax which they hold in their claws. On their arrival, they quit their burden, fix it to the work, and mould it with their feet, ſometimes on one ſide, and ſometimes on the other. All this is performed in a very ſhort time, after which they return to the fields, and are inceſſantly ſucceeded by others in ſuch crowds, that the comb increaſes rapidly. While ſome labour in the conſtruction of the cells, others are occupied only in faſtening the work and giving it the due degree of conſiſtence. For this purpoſe they

they are perpetually going over it, beating it with their wings, and the hinder part of their body. Bees conſtruct their cells with geometrical exactneſs, in the following manner: They begin to form the bottom, which is compoſed of three rhombs or lozenges. They firſt make one of theſe rhombs and then elevate two walls, on two ſides of this firſt rhomb. To it they join a ſecond rhomb with a certain inclination, as we ſhall afterwards mention, and raiſe other two walls on two of its ſides. Laſtly they add a third rhomb, and raiſe two planes on its two exterior ſides, which, with the four others, form a cell of an hexagonal figure. While one party of Bees is occupied in this work, another ſet are employed in finiſhing it. They retouch the ſides, the angles, and baſe of the cells with the moſt ſcrupulous accuracy; they faſten them, and work them ſo thin, that three or four of the ſides laid one on another, are not thicker than an ordinary leaf of paper. But as the entrance into theſe cells would be too weak if it were not thicker, they make a kind of rim to it, which ſtrengthens the entrance. By this means the bees can come out, and go in eaſily, without injuring their cells, which are proportioned to the ſize of the body of theſe induſtrious animals.

I have ſaid that the Bees occupied in conſtructing the cells, only labour for a ſhort time at once; but that is not to be underſtood of thoſe who have the care of finiſhing them. They are employed for a long time, and never quit their work, but when they carry away the little particles of wax which have been rubbed off in the poliſhing. This ſubſtance is not loſt: there are other Bees ready to receive it, or to go in queſt of it in the cells in which thoſe employed in poliſhing ſometimes, for a moment, retire to depoſite it; this ſuperfluous wax is made uſe of elſewhere. There is a third order of bees which ſeem

feem occupied only with miniftring to thofe that po-lifh. They are always at hand to furnifh them with honey, or other fluid fubftances that are neceffary both for their work and their fuftenance.

Each comb is compofed of two rows of cells laid clofe to each other, the bafe of each row being common. The thicknefs is fomething lefs than an inch; the depth of each cell therefore will be about five lines. I have often obferved that a comb a foot in length had from fixty to fixty-fix cells. According to this proportion, the width of each cell will be a little more than two lines, which is nearly a third of its depth: this meafure is that of almoft all the cells in the hive; there is but a fmall number larger: the width of thefe is fomewhat more than three lines, and the depth a little more than fix. Thefe large cells are deftined to contain the larvæ of the drones, which we fhall afterwards mention. We find befides in different places of the hive, three or four cells larger than the reft, and of a different figure. The mouth of thefe is in the underfide; they are attached to the extremities of the comb, and have the figure of a fpheroid. They are fuppofed to be the habitation of the queens; but I confefs I have never been able to afcertain this point.

The bafe of the combs is at fuch a diftance from one another that when the cells are finifhed there is no more fpace between two combs, than is fufficient to allow two bees to pafs back to back. The combs are not continued quite from top to bottom, but are often interrupted; there are befides certain openings at different diftances which allow a communication from one to another, both eafier and fhorter.

After having explained the manner in which Bees conftruct their cells, I find it neceffary to be more particular

particular with regard to their figure. The base of each cell is formed of three rhombs, as we have already said, almost always equal. According to the measurement I have made of them, each of the obtuse angles, is 110 degrees, and each of the two acute ones is consequently 70. These three rhombs are inclined to one another, and are joined by the sides which form one of the obtuse angles. The mutual inclination of these rhombs makes a solid angle, which on account of the general uniform equality of the rhombs, is situated in the axis or centre of the cell. The six other sides of the same rhombs, besides three obtuse angles form likewise three other angles by the reciprocal inclination, which forms their junction at the two acute angles. These six equal sides of the three rhombs are so many bases on which the bees elevate the walls which form the six sides of each cell. Each of these walls is a trapezium which has one acute angle of 70 degrees and an obtuse one of an hundred and ten; the two angles of the trapezium which are at the mouth of the cell are right angles. We must observe here that the acute angle of the trapezium is equal to the acute angle of the rhomb at the base, and the obtuse angle of the same rhomb is equal to the obtuse angle of the trapezium. The six trapeziums which form the six sides of a cell join one another at equal sides, and are connected to the rhombs of the base; thus the obtuse angles of the rhombs are contiguous to the obtuse angles of the trapeziums, and the acute angles of these last to the acute angles of the former. Such is the structure of each cell.

I come now to the manner in which the two ranges of cells constituting the comb are formed, and the way in which the cells are joined together. Imagine to yourself in the first place, several other bases similar to those we have described; suppose farther, these bases to be applied to one another in such

man-

manner that the ſimilar angles of the one ſhall correſpond to the ſimilar angles of the other, and ſhall join together exactly. In ſuch a caſe two of theſe baſes being joined to a third, three rhombs of theſe three different baſes will form the bottom of a new cell ſimilar to the firſt, with this only difference, that the concavity of the ſolid angle is turned to the other ſide of the comb, where there is another range of cells oppoſite to the firſt. By the junction of ſix baſes with a ſeventh, there will be formed three new baſes, which will have the concavity of the ſolid angle alſo turned in a contrary direction to that of the ſeven baſes. Laſtly the twelve new baſes united to the eight preceeding ones form nine others with the concavity of their angle oppoſite to that of the twelve. By this wonderful ſtructure are formed the two ranges of combs. Thus there are three lines of rhombs on three different planes, ſo well executed that ſeveral thouſands of rhombs of the ſame line all reſt on the ſame plane. Is it not truly ſurpriſing then, that ſo many thouſands of animals, aided by natural inſtinct alone, ſhould agree together in forming a work ſo difficult, with ſo much order and regularity?

Bees do not give their cells ſo determinate a ſtructure without deſign. I have ſaid that each baſe is formed of three rhombs, and that on each ſide of theſe rhombs there is a wall which ſerves as a ſide to the oppoſite cell. Thoſe three walls, beſides ſerving as a ſide to part of a cell, likewiſe ſerve for a ſupport to the baſe of the oppoſite cell, and ſupply the defect ariſing from the great tenuity of the work. Moreover, the concavity of the ſolid angle which is in the middle of the baſe, ſerves by an admirable effect of divine providence to collect into a ſmall ſpace the particles of honey, which the Bees daily furniſh to the little larvæ, as I ſhall afterwards ſhew. If the bottom had not been diſpoſed in this manner, the honey which is at

Q firſt

first fluid, would have run out, and the embrio would have perished for want. It is not the figure of the bottom only which is favourable, many advantages arise from the number of angles in the rhombs. On the size of them depends that of the angles of the trapeziums which form the six sides of the cell. Now, as the acute angles of the rhombs are 70°. 32′ and the obtuse ones 109° 28′ those of the trapeziums contiguous to them, must be of the same degrees respectively. Besides, by this number of angles in the rhombs, the solid angle of the base is equal to each of the three solid angles made by the obtuse angle of the rhomb, with the two obtuse ones of the Trapeziums; from this greatness of the angles, therefore, there results not only a greater simplicity in the work and greater facility for the Bees, who thus make use of only two sorts of angles, but likewise greater symmetry in the disposition and figure of the cell.

The figure which Bees give to their cells is a regular hexagon. Pappus, a celebrated Geometrician of the second century, has observed that it looked as if these little animals had a particular acquaintance with geometry, when they gave such just proportions to their cells. Nor could they have chosen a figure which would have afforded them a greater number of cells in the space contained in their hive. The property of this figure is that many united together completely fill up a space round a certain point without leaving any void whatever. The same property belongs to two other figures, to wit, the equilateral triangle and the square. But neither of these have the capacity of the hexagon. It is therefore with great wisdom, continues the same Geometrician, that Bees make use of that in preference to every other figure. For if the same quantity of matter is employed in the construction of a triangle, a square, and a hexagon, this last will contain more honey than the others.

The

The fecond example of induftry and fagacity in infects fhall be taken from wafps, thefe animals conftruct their neft, either in the earth, or fufpend it from fome new building: They do not begin their fabric like Bees at the top; but like ordinary architects they lay their foundation, and raife the fuperftructure in the common way. The nefts of all the fpecies are not of the fame fhape. Some are of the figure of an oblong, fome of an oblate fpheroid: fome are conical, with the apex irregular and truncated, fomething like that of certain fea fhells, and fome refemble a bottle with a long neck. The cells in the greater number of wafp-nefts are hexagonal, and furrounded externally with a white integument of a woody fubftance refembling the dry pods of kidney-beans. The upper part of this integument ferves as a roof to the whole edifice; it fecures the neft from humidity, which in running along it, might incommode the wafps. The fides ferve as walls to defend the inhabitants from injury; and the under part is as it were a bafe to the whole fabric; if the integument is removed, the infide difcovers fix ftories at equal diftances from one another. But leaft one fhould fall and demolifh thofe below it, each ftory is fupported by feveral columns which are broad at the bafe, and grow broader again at the top, fo as to form a kind of arch.

The fame elegance is not lefs remarkable in the ftructure of thofe nefts which are fhaped like a bottle with a long neck. The external cover is thin, like tranfparent vellum. The learned Aldrovandus, having cut one of thefe nefts longitudinally found it defended with three other integuments which like the firft, were of the fhape of a bottle, but without the neck. In the centre of all thefe covers, he found feven hexagonal cells.

From the nests of wasps I pass to the subterraneous vaults of ants. These insects have a common storehouse and no ant makes any provision for its own individual use. This storehouse is divided into several cells, the avenues to which correspond to one another. They are extended so far within the earth, that neither rain nor snow can reach them in winter. The caverns of human formation are far less artfully and skilfully contrived than those of these little animals. When they are completely finished, any attempt to destroy them is vain: for their excavations are so extensive that when once the entrance is demolished, it is not possible to trace the turnings and windings of their labyrinth.

The manner in which some insects form to themselves a habitation on the leaves of plants must not be omitted here. The tube through which they lay their eggs is at the same time a sting with which they puncture the leaf they mean to lay them in. But lest the larvæ should be encumbered for want of room, they discharge a certain fluid into the hole which occasions a tumour or elevation on the leaf, in which the young are at their ease. These tumours vary in appearance; some are like hard shells, such as the Aleppo galls; others like little soft balls; some are scaly, others smooth, and some hairy; as to shape, some are spherical, others in the figure of a cone.

But it is not in the structure of their habitations alone, that insects display their sagacity and industry; the astonishing precautions they take to secure themselves from injuries of every kind, are no less demonstrative of these qualities. Such of them as disagree with wet, avoid it with the greatest dexterity. Is wind hurtful to any of them? the places they frequent, and the structure of their nests, suffi-

ciently

ciently defend them from it. Is heat inconvenient to them? they take up their abode in the ſhade. As the greater part of them during winter are in a ſtate of torpor, they generally choose a place where they may remain through that ſeaſon ſecure from its inclemency, or they conſtruct habitations that are ſufficiently fitted to defend them.

Although I have ſpoken above of the artifices and addreſs which ſome inſects put in practice, in order to ſeize their prey, it is a ſubject which demonſtrates in ſo ſtriking a manner their aſtoniſhing ſagacity that I cannot help in this place, adding ſome farther remarks on it. Some are ſeen as I have already obſerved to wait patiently for their prey, till it comes within their reach, when they inſtantly dart upon it, and ſeize it. This is done with a velocity equal to that of an arrow. Not to loſe the fruit of their watching, when they have once ſeized their prey, they preſerve it with all the circumſpection poſſible. If any of them want the neceſſary ſtrength for this purpoſe, by being weaker than their priſoner, they call another to their aſſiſtance.

Thoſe that ſpin, give an admirable proof of their dexterity in the performance of this function. It muſt here be obſerved, that the wiſe author of the univerſe has abundantly furniſhed them with a ſoft and glutinous ſubſtance which is eaſily fabricated, and which hardens in the air. Inſects have the faculty of drawing this from their bodies, either by the mouth or the abdomen. The threads they form are not all of the ſame quality; they differ according to the different animals that ſpin them. Some make them exceeding fine and ſlender; while thoſe of others are coarſe. It is eaſy therefore to imagine that the web they weave will correſpond to the thread they employ. Some have the ſoftneſs of the fineſt

wool,

wool, and the web of others has the ſtiffneſs and ſtrength of parchment.

The method of weaving is different in different inſects. In the webs of ſome, there ſeems to be neither order nor deſign; but others obſerve the moſt exact proportions. These take their dimenſions with ſo much accuracy, that an Archimedes could not meaſure them more perfectly with his compaſſes. But what would be the effect of reaſon in a Geometrician, is done by mere inſtinct in theſe animals.

Inſects ſhew themſelves to be as ſkilful dyers, as they are dextrous weavers. They do not ſpare the moſt beautiful colours in the webs they form. Sometimes they are yellow, ſometimes blue, grey or brown; but their colours always ſurpaſs thoſe which the moſt ſkilful dyer could give them. When the rays of the Sun happen to fall on ſome of theſe webs, the ſplendour of their colonrs is ſo great as to ſurpaſs deſcription; and exceeds the beauty of the rainbow, or the brilliance of the diamond.

Many caterpillars with wonderful dexterity let themſelves down, and re-aſcend by means of a thread iſſuing from their body, and ſtrong enough to ſupport them. This operation they perform when they want to eſcape from ſome danger or to go elſewhere in queſt of food. The manner in which they get up by this thread, is exceedingly curious: they uſe their teeth and their feet, as men uſe their hands and their legs when they climb up trees, but ſomewhat differently; the latter claſp the tree with their hands as high as they can reach, and then draw up their legs; the caterpillar ſeizes the thread by which he is ſuſpended, with his teeth, as high as he can, then turning his head to one ſide, he raiſes his fore-
moſt

most feet above his head which grasp the thread and after having seized it, he restores his head, and takes hold of the thread still higher; then again bending his head, and grasping the thread with his feet he continues to ascend, till he reaches the place from whence he let himself down.

The wise form of government among Bees, is too wonderful not to find a place in this chapter. They have at their head a Queen whose ability in the art of governing her people is not less worthy of our admiration than that of those Princes who have acquired the greatest fame by the wisdom of their reign. The power she exercises over her subjects is more absolute than that of the Grand Seignior surrounded with his Janissaries. But her despotic authority never degenerates into tyranny: she never is guilty of cruelty to her subjects; the promptitude of their obedience secures them from punishment. Neither the desire of independance, nor envy, nor any other passion, ever occasion among them, sedition or tumult. How much below these little creatures are men in this respect! With what sanguinary fury do they not often rebell without reason against their superiors! What disorder have not their mutinies spread in the society of which they were members? But let us return to our Queen.

It is she who alone commands, whether it be to work, to fight or to swarm, every thing depends on her alone. She no sooner promulgates her orders, than her subjects fly to execute them with incredible ardour. On this subject I shall relate the observations of an ingenious Englishman:

"Many years ago, (says Mr Warder in his Monarchy of Bees,) I having a mind to satisfy my curiosity about the queen-bee, was resolved to run the

the hazard at leaſt of deſtroying a ſwarm of bees for that purpoſe; ſo in the morning, about half an hour before ſun-riſing, I took a ſwarm of bees that had been hived the morning before, and carried it into a meadow adjoining to my garden, and there with a ſtrong ſtroke upon the ground, ſhook the bees all out in a lump upon the graſs. And as ſoon as they were a little quiet from the diſturbance that ſo violent a motion cauſed; I laid myſelf down on the ground, and with a little ſtick in my hand, gently ſtirred the bees, in order to find the queen bee, and having deſcribed her to three or four of my family, which were then with me, deſired them as I ſtirred the bees, if any of them ſaw ſuch a bee to ſhew her to me; all being thus upon the ſearch, at length one of them diſcovered her, and pointing to her, I ſaw her, and quickly caught her in a box which I had ready for that purpoſe, and carried her into my parlour, where opening my box, I let her fly, and a few of the other bees who were taken with her, who as is natural to them, did fly againſt the glaſs window, ſo taking a ſharp pair of ſciſſars I cut off one of her wings to diſable her from flying, and then put her again into my box. The firſt thing I was willing to know, was what they would do without their queen; but this was ſoon diſcovered, for they were in a quarter of an hour like ſheep without a ſhepherd, (which was as ſoon as the whole bunch could know that the queen was not amongſt them,) which they ſoon diſcovered, by ſpreading themſelves abroad upon the graſs; for whereas it is natural to theſe creatures to keep cloſe together like a bunch of grapes, they now ſpread themſelves as broad as a cart wheel, running up and down, and with a piteous and diſcontented note ſearching for their queen. So when they had ſpent an hour or thereabout in this fruitleſs ſearch, they took wing, and flew to a hedge, and there pitched, in which flight and pitching, there

were

were two things remarkable. First, that they flew to the same hedge, where the swarm had pitched the day before, to search for her there, where they last had her company. Secondly, how soon by the absence of one bee, this monarchy was turned into anarchy; for now (instead of going all together in a bunch, which is natural to them when they have their queen,) they were divided all along the hedge, for ten yards together in little bunches, forty or fifty in a bunch and some larger bunches; so then I pulled the box out of my pocket where the queen bee was, being willing to know whether or no they would again acknowledge their crippled Sovereign, and my thoughts then were, that they would not, she having been so long from them, and her wing cut off, or for the smell of the box, I did not know but these, or some of these might give them some distaste; but to my great amazement and all that were with me, I no sooner opened the box, and laid it, queen and all upon the bank, near to one of these little bunches, but they immediately began to gather from hither and thither all about my box where the queen was, which was soon covered up, and in less than a quarter of an hour, they were all gathered together about their queen, rejoicing, which rejoicing is easy to perceive by those that are used among them by their notes. So having found their queen again, they lay all contented together, not running up and down, and spreading themselves as before, when she was absent. So night coming on, I again hived them, and brought them into my garden, for if I had let them remain abroad all night, the coldness of the night would have chilled them; so that I should not have been able to make any farther discoveries with them. Next morning, being fine weather, I again knocked them out on the grass, in the meadow as before, where they soon united themselves together about their beloved queen,

R where

where I let them lie for ſome hours, to try if they would riſe; but here was the height of loyalty expreſſed. The poor queen, as I told you above, had one of her wings clipt, and ſo was not able to fly, and lead them off to ſome place for their common preſervation, and theſe her loyal ſubjects choſe rather to periſh with her, than to leave her in her diſtreſs. Then I again took away their queen, and put her in a box as before, and my poor bees fell again to ſpreading themſelves in ſearch of her; ſo when they were thus ſpread abroad, I laid down their queen, near one ſide of this ſearching ſquadron, when to my great ſatisfaction, and wonder of ſome friends, which I had ſent for on purpoſe, they all immediately ceaſed their ſpreading themſelves, and ſearching every way for their queen, they all marched directly towards her! Before they had quite covered her, to ſave myſelf the trouble of ſearching for her in the midſt of the ſwarm, I took her up and laid her down on the contrary ſide, to where I took her up, when preſently you might ſee them all turn their march to her again; ſo I often took her up from one place and laid her down in another, and theſe poor loyal and loving creatures always marched and counter-marched every way as the queen was laid. When I had ſhewed my friends all the diverſion that ſo great a curioſity could afford them, I ſuffered them again to encircle her, and immediately they cloſed from the right and left, front and rear, into a thick round bunch, no broader than the crown of my hat, and ſo lay very well contented together; the commons ſtill expecting when they ſhould fly with their queen as uſual; but ſhe not being able to fly, could not lead them off, and not a Bee of them would offer to leave her, though by this time, no doubt but they began to want food; ſo the evening drawing on, I again hived them, and brought them into my garden

to prevent their being chilled; and the next morning knocked them out upon the grafs, where to try farther experiments, I often took away their queen, and with her could march them any where, this way and that way, and then put her to them again; for I was refolved now to try whether or no thefe loyal creatures would go on thus to the end, and crown thefe their loyal principles with martyrdom. The Commons tafted no food, nor would they fly to get any, unlefs their queen had been in fafety. And indeed this their loyalty and affection was equalled, if not out-done by their queen; for when I had her away from them, I gave her honey feveral times, but fhe would not fo much as once tafte of it without her fubjects. But to come to a conclufion of this curious though melancholy obfervation, they ftill kept their integrity, and famine itfelf could not leffen their loyal affection to their Prince; for after they had lived five days and five nights without the leaft food, they all died of famine, except the queen-bee, who lived fome few hours longer than her fubjects, and then died; difdaining a life, that was no life to her, without the company of thofe which fhe could not have, they having all given up their lives for her fake."

There are in the Monarchy of Bees many other circumftances which fhew the order and admirable policy which reigns among them: thefe are too nearly related to the fubject of this chapter to be omitted. The queen has her guards who have the charge of her fafety; fome like body guards are ftationed in the antichamber of her apartment, and others ftand centinels at the gate of the palace. She never moves a ftep without being attended by her guards or being efcorted by crowds of other Bees; if fhe goes out, the reft follow her; if fhe ftops, they ftand ftill; if fhe goes into the hive again, they all attend her.

As they deposit their whole store in a common magazine, it is just that each Bee should contribute to the heap by its own labour. Accordingly they never suffer an idle member whose inaction would derange their economy, and who would waste the provision which it costs them so much labour to collect. By virtue of this sage law they expell the drones from their hive, which do nothing but consume the honey; they drive them away with rigour, and even in certain circumstances kill them.

When in Spring their magazines are exhausted, and the flowers not yet in sufficient abundance to furnish them with food, they are obliged to live by pillage. The necessity of their circumstances often occasions bloody wars in which great numbers always perish. They seldom attack the hives in their neighbourhood, but like Tartars they over run vast fields and halt at places remote from their own dwellings. They do not attack indifferently every hive; some are too strong, and would make them repent their temerity. But after mature examination of the strength and numbers of the whole, they fall on the weakest, and gorge themselves with plunder. If the success answers their expectation, they return next day with a reinforcement, and continue this predatory war, till they reach the inmost treasures of the hive. The bees which are exposed to this pillage, do not suffer it tamely. They endeavour to disappoint the assailants, with the most vigorous efforts. No sooner have these given the signal by a humming more loud than ordinary, than they prepare their sting which serves them as a sword ready for their defence: the guards are encreased, and they march boldly to oppose the enemy; the action, as is mentioned above, is generally fierce and bloody, and great numbers on both sides are left dead on the field of battle. The queen being as it were the soul of the hive, it is easy

to

to imagine that their greatest care will be to secure her from the fury of the invaders. If she has the misfortune to fall in battle, the whole army is dispirited, and victory declares for the assailants.

If the bees in a hive are hampered for room on account of their numbers, or if there happens to be more than one queen, they send off colonies which go to settle elsewhere. The queen of this detachment puts herself at the head of her subjects, who follow her without knowing whither she is to lead them. When she has pitched on a favourable place she stops, and lays the foundation of a new kingdom.

I must not omit to mention the respect they shew to their dead. It does not appear that they neglect the carcases of those that have perished, but carefully convey them away. If one bee is not sufficient, two join to perform the task: the one takes the dead body by the head, the other seizes it by the tail, and thus they carry it thirty or forty paces from the hive with their legs only.

If we consider maturely the different instances of sagacity which I have in this chapter related of insects, we cannot but be struck with wonder. There is something in them all which, if it does not surpass the cunning and subtilty of the mind of man, at least very nearly approaches them. It cannot be the effect of chance, for there is an evident display of design, and a constant regularity, which demonstrates that an all powerful and all wise being directs them. Fix your attention for a moment on the different ways in which I have said that insects construct their nests. It requires a deal of time before a man who is endowed with intelligence, by which he is so adventagiously distinguished from these animals can acquire

a

a ſufficient acquaintance with geometry to be able to take with certainty the juſt dimenſions of any given body; and an architect muſt ſerve a long apprenticeſhip before he is able to build a regular and convenient houſe; but theſe little creatures geometrically, and with the greateſt accuracy, conſtruct their houſes, in which they are to dwell for a time. With whom have they ſerved an apprenticeſhip to ſo difficult an art? What maſter has made them ſo perfect in ſo ſhort a time? Who hath pointed out to them the materials moſt proper for the conſtruction of their abodes? Who hath taught them the proper time for commencing their operations? What mathematician hath diſcovered to bees the moſt convenient figure for the ſtructure of their cells? How does each ſpecies know the kind of houſe which is beſt adapted to it? How happens it that no one ſpecies ever forſakes its own manner of building, for that of ſome other ſpecies? Of whom has the ſpider, an inſect otherwiſe ſo vile, learnt to ſpin ſo fine and delicate a thread? From whom has ſhe received the art of fixing it to ſomething firm when ſhe is about to make a web? Who hath taught her to unite the whole in a common centre, and to connect them by a kind of ſpiral line which forms circles at equal diſtances from one another? How has ſhe been able to foreſee that this web would be ſerviceable in the catching of other inſects which ſhe could not have ſeized without this artifice? What compaſſes has ſhe made uſe of in order to find the centre of her work in which every thread terminates, and where ſhe perceives the ſmalleſt motion, which is made in the whole extent of her web? How happens it that ſhe never miſtakes the road in her way towards the priſoner whoſe exertions inform her of his captivity? Who hath informed ſome of thoſe inſects to guard themſelves from heat and others to defend themſelves from wet and the wind? How do almoſt the

whole

whole of them know without having experienced it, that they cannot ſupport the rigour of winter without making the requiſite preparations for putting themſelves in ſecurity from the cold? In the ſchool of what ſportſman have they been trained to ſeize their prey with ſo much addreſs? Who hath made them ſo cunning in the art of laying ſnares for their enemies? What maſter have ſome had to teach them to ſpin threads finer or coarſer according to their neceſſities? Who hath furniſhed their bodies with the matter theſe threads are compoſed of? Who hath diſcovered to them that they are provided with a ſubſtance proper to be employed for this uſe? What weaver hath taught them to form with it a web ſo exquiſite? Whence comes the vaſt variety there is between the webs of the different ſpecies? What dyer hath taught them to give their threads ſometimes one colour and ſometimes another? Of what profound politician have thoſe been taught who live in Society? What Lawgiver hath formed their conſtitution? What General hath taught them the art of war? But I am tired with aſking ſo many queſtions; queſtions which cannot be anſwered but by admitting the operation of a being all powerful and infinitely wiſe and good, who hath given inſects the neceſſary powers aud faculties for performing thoſe functions which make the object of our admiration.

Let us now make it our duty to admit a truth founded on ſuch ſtrong and convincing proofs, and let us ſay with the wiſe man, "The Lord by his "wiſdom hath founded the earth, by underſtanding he "hath eſtabliſhed the Heavens, and by his knowledge "the depths are broken up." Prov. iii. 19. 20. May we not ſay without exaggeration, that God hath acted with regard to inſects as he formerly did to Bezaleel. "He hath filled them with the ſpirit of God, "in

" in wisdom, in understanding, in knowledge, and in " all manner of workmanship, to devise cunning " works and in cutting of stones, and in carving of " timber to work in all manner of workmanship." Exod. xxxi. 3-5. As it was he who enriched that skilful artificer with such excellent and various talents we cannot doubt but it is also he who hath given similar talents to insects. He who gave to " Solomon wisdom and understanding and largeness of " heart, even as the sand that is on the sea shore, " and excelling the wisdom of all the children of the " east, and all the wisdom of Egypt, and that of all " the wise men of his time," Kings iv. 29. 31, has given to insects that sagacity, foresight and industry, which we have observed in their economy. Every perfect gift originates from the same cause, and descends from the father of lights.

Insects, though unendowed with reason exhibit the strongest proofs of a particular wisdom; while men often transgress its rules, and disobey the laws it prescribes to them. How disgraceful to human nature is this humiliating parallel? Shall despicable animals conduct themselves with more prudence than intelligent beings; shall they consult their instinct and never wander from its dictates: and shall man, proud of the faculty which distinguishes him from the brutes, shall he not deign to consult his reason? what culpable, insensate conduct! But this is not all: the young of insects are guided by a natural movement, and without any other education, to pursue the conduct of their parents: but it is quite otherwise with children; the faculties of their mind must be cultivated by a good education, the reason which God hath given them is a rough diamond, which their parents are obliged to polish, and to set, if they would answer the purposes of their creation. But is this done by the generality of man-

kind? It is but too common with many to abandon their children to their own wills and totally to neglect their education. Can we then be otherwise than surprised to see so many intelligent creatures conducting themselves with less reason than brutes? What are we to infer from these reflections? Is it not that as insects answer exactly the purpose of their creation by making the proper use of their faculties, men ought also to second the views of the supreme Being by employing their reason to the advancement of his glory, and to that of their own felicity? They ought to cultivate with care the inestimable gift of reason, and endeavour earnestly to make their children follow their example.

INSECTO-THEOLOGY.

BOOK II.

CHAP. I.

Of the senses of Insects.

The senses are indispensably necessary to all animals. How could they escape danger if they did not see? How discern the food that is agreeable to them if they had not the faculties of taste and smell? How avoid their enemy if they did not hear, by the noise he makes, on what side he approaches them? If deprived of touch, how could they distinguish pleasure from pain? How know health from disease?

When I say that the senses are indispensably necessary to animals, I do not mean that they must possess the whole which we enjoy. It is sufficient that the Creator has bestowed on them as many as are necessary for their preservation in their respective situations

tuations. This is the caſe with inſects; they have not always five ſenſes like man. Some are deprived of ſight, ſome of ſmell, others of hearing; but never except when the manner of life they lead renders theſe unneceſſary or uſeleſs.

Feeling or touch is common to all animals as Pliny obſerves. The ſenſe depends on the motion of the nervous fluid communicated to the brain, and affecting the ſoul. This motion is excited under the ſkin by the impulſe of ſome external body; it communicates itſelf to the nerves, is by them inſtantaneouſly carried to the brain, and there cauſes a ſenſation of pleaſure or of pain. The nerves which have all an immediate connection with the head, are affected in the ſame manner as a cord well ſtretched: the ſmalleſt motion made in it is communicated at once to the two extremities. It is remarkable of this ſenſe that it reſides in all parts of the body whereas the others have each a particular organ ſeated in the head. By this means animals are informed of all the derangements, exterior as well as interior, which can happen to them.

What I have ſaid in the laſt Chapter, evidently ſhews that inſects are endowed with the ſenſe of touch. It muſt have been remarked how careful they are to ſecure themſelves agaiſt wind, rain, heat, cold &c. which certainly they would not do were they deprived of this ſenſe. The delicacy of the organs of touch, is not the ſame in all. There are ſome which are ſenſible to the ſmalleſt impreſſion, while others do not ſeem to feel even a pretty ſmart ſtroke, as if endowed with an almoſt ſtoical inſenſibility. There is reaſon to believe that ſome inſects are to be found, deſtitute of all other ſenſes but that of feeling.

Sight is a ſpecies of touch: the rays that come from an object falling on the eye affect the retina; the motions they occaſion there are communicated to the optic nerve, and produce the ſenſe of ſeeing. Although many inſects are endowed with this ſenſe it is not common to them all. Some of thoſe which enjoy it, have it in greater perfection than man. Their ſight is ſo quick, that it comprehends, if we may ſo ſpeak, even an atom. We cannot view objects behind us, without turning round our head; but there are many inſects which, without ſuch motion, can ſee all the objects which ſurround them. Men in general cannot ſee in the dark, but many inſects ſee better in the night than in the day.

God has not beſtowed the ſenſe of hearing on all inſects; and I know none that have ears; we cannot however doubt, that there are many which are endowed with this ſenſe. As the lovers of muſic aſſemble at the ſound of the inſtruments they like, we ſee many inſects collecting together at certain ſounds they are pleaſed with. A diſagreable noiſe diſturbs and frightens others. This is more ſurpriſing if, as I have ſaid they have no ears to ſerve as the organ of hearing. When a noiſe is made, a tremulous motion is communicated to the air, which ſtriking on the tympanum of our ears, is by the animal ſpirits conveyed to the brain, and produces in us the ſenſe of hearing: this is ſimple, and can be eaſily conceived. But how can this happen without ears?

Inſects have nothing like a noſe, but we cannot for that reaſon deny that they poſſeſs the ſenſe of ſmelling. We obſerve that they often diſtinguiſh ſmells; and that they are ſenſible of the perfume that exhales from odorous ſubſtances. Their inclinations in this reſpect differ very much; ſome give the preference to thoſe ſmells which we think agreeable, others are attracted by the odour of ſubſtances which they gree-

dily

dily seek after, while others more delicate avoid them and fly from them with the greatest aversion. The sense of hearing in insects is more acute than in man of which I know two instances. The first is, that they discover their food by this sense, and can distinguish by it the qualities of vegetables; the second is that they can smell the food that is agreeable to them at a much greater distance than man can. But we are more than recompenced for our inferiority in this respect to insects: the reason we are endowed with, enables us to dispense with such exquisite delicacy of smell, and is preferable to any advantages which insects have over us.

Taste is a motion of the animal spirits excited by particles acting on the nerves of the tongue which communicate that motion to the brain, and thus affect the soul. Insects have no tongue like other animals, but their trunk and their palpi, of which we shall speak in the sequel, serve them instead of it and are the organs of their taste. This sense is of great use to them; by it they distinguish between food that is salutary, and food that would be noxious to them. What I have remarked, in some of the former Chapters with regard to the food of insects, shews clearly, that the sense of taste in these creatures is very various. What some love, is abominated by others; some live on fluids, others on solids; some live on the green blade, others on the dried grain. Some delight only in the juice of flowers; others suck the blood of animals. To these last, every species of blood is not equally agreeable; some preferring that of man, others that of quadrupeds, no do they attack every quadruped indifferently. Lastly there are insects which devour animal substances, some when it is fresh, others not till it becomes putrid.

Insects though destitute of the organs of some of the

the senses are not however deprived of the feelings they occasion. Hitherto the ears have not been discovered in any insects; the greater part have nevertheless the sense of hearing in a very eminent degree; they have no nose, and yet their sense of smell is exceedingly delicate. What greater instance can be desired of the infinite wisdom of the Creator, which is not confined to a single mode of producing the effect? If the greater part of animals have ears, as the organ of hearing, and a nose, as that of smell, this is not a proof that the ears and the nose are absolutely necessary to produce these sensations. God can when he pleases form creatures capable of experiencing the same sensations by means of other organs. Should it be objected that insects, which are sensible to smells and to sounds, must have a nose and ears, but that the structure of them is so fine and so delicate that we cannot discern them even with the assistance of a good microscope, the wisdom of the Deity would not on that account be less the subject of admiration Would we not have reason to be astonished at the extent of the power and wisdom of a being who has given sensations to organs so minute as to have hitherto escaped the most diligent scrutiny of the curious? How delicate must be the nerves which tremble at the smallest impressions made by external objects! How subtile must be the animal spirits, which can produce in the soul of these creatures, those motions which lead them to provide for their preservation.

The use which insects make of their senses corresponds exactly to the views which the wise author of nature from whom they derive them, proposed when he formed them. Far from employing them in procuring to themselves extravagant pleasures or excesses of any kind, they never use them but to answer their necessities, or as the means of their preservation. How great is the difference in this respect between

tween them and man! who allows himſelf to be led aſtray by voluptuouſneſs, and by all the pleaſures of the ſenſes, as if the faculty of reaſon had not been beſtowed on him, and as if he had not the power to reſiſt his inclinations. Let us learn from theſe deſpiſed animals to mortify our paſſions, to indulge in no exceſſes, and to confine our ſenſes to thoſe uſes for which they were given us. How diſgraceful is it for a rational being to confeſs himſelf in this reſpect inferior to the brutes! Let us fly from luxury, let us ſhun pride, and the vanities of life, and let us employ all our ſenſes in contemplating the works of God, as well thoſe of nature as thoſe of grace. Let our ears be ſhut againſt whatever is wicked or indecent, and open only to the important ſound of the word of God. Let us not abaſe the organ of our taſte by exceſs in eating or drinking, but let us uſe it for our preſervation, by living ſoberly and frugally. It is our duty to take care of our bodily frame; but it is a crime to idolize it, to attend only to its pleaſures, and to ſatisfy all its inordinate appetites.

Man enjoys five ſenſes, while inſects want ſometimes one ſometimes another. The Deity has alſo beſtowed on him a rational ſoul which indemnifies him for the ſuperiority that inſects have over him with regard to the ſenſibility of their organs. What thanks ought we not to render him for gifts ſo valuable! To form a juſt eſtimate of the importance of thoſe gifts, let us ſuppoſe for a moment that we have loſt the uſe of one or more of our ſenſes; we ſhall then be convinced how indiſpenſible they are to our pleaſures and convenience. Blind, deaf, without feeling, without taſte or ſmell, what would become of us! Our body would be nothing but a lump of clay, and our ſoul incapable of providing for its ſecurity and preſervation. Let us then praiſe and exalt the author

Our

of ſo many bleſſings; let us teſtify on all occaſions the gratitude our hearts are filled with, for his having brought us into exiſtence, and for the gifts of reaſon and the ſenſes which make that exiſtence delightful.

CHAP. II.

Of the members of Insects.

For the ſake of order I ſhall divide this Chapter into two Sections. In the firſt, I ſhall diſcourſe of the external parts of inſects; in the ſecond I ſhall treat of their internal ſtructure. As the former are more eaſily diſtinguiſhed than the other I ſhall be more diffuſe upon that ſubject, and begin with it.

Section I.

Of the external members of Inſects.

As all inſects have a ſkin I ſhall begin what I propoſe to ſay of the parts of inſects, by a deſcription of this member.

The ſkin is the moſt external integument which nature has given them: it covers their whole body, connects the different parts and retains them in the places to which they are aſſigned. It is not of the ſame quality in every inſect. Thoſe whoſe manner of life, does not expoſe them to compreſſion, or to violent

lent friction have the skin very delicate and tender. Some have several skins one above another nearly like the different coats of an onion. The skin of man and that of the other animals is filled with an infinity of small pores; it resembles a sieve or very fine net, the pores answering to the meshes. By these pores transude a quantity of superfluous humours which are thrown off by sensible or insensible perspiration. The skin of insects has likewise pores for the same use, and so small, that they are with difficulty seen. As some animals change their hair and even their skin every year, experience shews us that insects do the same. Some throw it off but once a year, others four times.

Insects which creep into holes, or fissures, where they are exposed to pretty violent rubbing, have their skin harder than others: and even some have it fortified with scales. It likewise serves to defend insects from the injuries of the weather; it is of the same use to them that scales are to serpents and fishes, shells to crabs or shell fish, feathers to birds, and hair to the most of quadrupeds. As insects in general are but small, the heat of the Sun would soon dry up the internal humidity of their bodies, and exhaust their animal spirits, were not they enveloped in a hard skin, which prevents that inconvenience. It is the instrument of motion to those that want feet; by extending and contracting it alternately, they transport themselves from place to place.

Lastly, the skin of insects may be considered as a coat of mail with which God has armed them as a protection from external danger. "Thou hast cloath-" ed me with skin," says Job, Chap. x. ii. to express the means which God had employed to unite, connect, and preserve the different parts he was composed of. The Deity has been equally attentive to

infects, and it is for the fame purpofe that he has likewife cloathed them with a fkin.

It is fo difficult to diftinguifh the head of fome infects that one would be almoft tempted to believe they had none. Some have it exceeding fmall in proportion to their body, others very large. It is not in all of the fame fhape; it is round, flat, oval, broad, acuminated or fquare in different infects. In fome it is fmooth, in others rough, and fome have it fet with hairs to fuit their manner of life. There is alfo great diverfity in the fituation of the head. In fome it is quite diftinct, but in others it is not eafy to difcover it. Some conceal it under their back, like Tortoifes under their fhell, fo that it cannot be feen. Though moft have it ftraight forward, fome have it bent down, and fome have a triangular mark on their forehead.

Winged infects which have feet are furnifhed with antennæ on their head, above the eyes, though fome have them feated on the roftrum, as all the Curculios. In the antennæ there are many articulations that infects may bend them with facility, and the number of the articulations varies with the neceffities of the various infects. It is rare to find caterpillars with antennæ, but there is a brown caterpillar which lives in fociety that is diftinguifhed by antennæ with three articulations. Thofe of the mufk beetle have four, thofe of the pediculi of the Peacock, five; thofe of the aphides of the cabbage, fix; thofe of the Ichneumons that are bred in the body of the caterpillar with 72 folds, feven; thofe of fome beetles eight. There are infects which have ftill a greater number of articulations in their antennæ. Such are all the fpecies of Cerambyx which have ten; the earwig eleven; the Tipula phalænoides has fourteen; and the ichneumon that breeds in the body of the

green

green caterpillars which curl up the leaves has sixteen; the antennæ of a Phalæna which feeds on the alder has forty articulations, those of the Phalæna Euonymella fifty; and those of another bred on the willow sixty. Lastly in those of some grasshoppers, there are from eighty to an hundred articulations.

These articulations are not of equal size. and some are longer than others; some are formed of little spherical bodies like a string of beads, more or less distant; these beads are bare in some, but garnished with hairs in others; in general they are so small that they cannot be seen distinctly but with a glass. In some insects they are hemispherical, in others heart-shaped, and lastly some are toothed like a saw.

The extremity of the antennæ in some insects is thickest, forming a knob, the whole somewhat of the figure of a drum-stick. That knob is sometimes cleft and divided into several branches. The shaft of the antennæ is sometimes smooth, and sometimes fringed. These last are of two sorts, the one having fringes only on the outside, the other on both sides, like the feather of a bird. This is their appearance when seen with the naked eye, but if a magnifier is employed, we find that each particular filament of the fringe is itself a feather, having a quill and a plume like those of a bird.

The antennæ are seated on small tubercles yb which the insect can bend them in all directions. They are not always carried in the same way, some insects bearing them straight forwards, others bent, others turned aside, according to their manner of life.

Antennæ have been given to insects with different views and for different purposes. It appears to have

been the principal intention of the Creator that they ſhould ſerve inſtead of hands, as they feel objects with them in order to judge whether they are uſeful or pernicious. When duſt has fallen upon the eyes of ſome inſects it is with their antennæ that they clean them. It is the more neceſſary that they ſhould be provided with the means of removing this duſt as they have no eye-brows, and are therefore more expoſed to the inconvenience. In this caſe the antennæ are of the ſame uſe with our fingers. They likewiſe ſerve inſects as the organ of ſmell, and by them they diſcern odours both near and at a diſtance. The males employ them in careſſing the females. They are a ſort of meaſuring rod to others, with which they ſound the depth of the holes they mean to retire to. Laſtly, as we have obſerved above, the antennæ are one of the marks by which the males of many ſpecies may be diſtinguiſhed from the females.

The ſtructure of the eye in man and other animals demonſtrates, in the moſt inconteſtible manner, the power and wiſdom of him who made it; but, the evidence of theſe perfections, drawn from the ſtructure of the eye in inſects, is not leſs ſtrong. It is true that ſome inſects are deſtitute of the organ of ſight, but by far the greater number are poſſeſt of it. The form of their eyes is very various; ſome have the luſtre, and almoſt the roundneſs of pearls, ſome are hemiſpherical, others ſpheroidal. They are not all of the ſame colour. We ſee many butterflies with eyes as white as ſnow, thoſe of ſpiders are quite black, thoſe of ſome aphides are of the colour of amber, of jaſper or vermilion; the brilliancy in the eyes of ſome of the muſcæ is like that of gold, for which reaſon they go by the name of the golden-eyed flies; thoſe of the green graſshoppers have the colour of an emerald; laſtly, the eyes of ſome have

as

as much fire and brilliancy as a diamond exposed to the rays of the sun: these colours, however, fade after the death of the insect, and sometimes totally disappear.

The eyes of insects are generally placed in the forehead, under the antennæ: but this rule is not without exceptions, for some have them behind the antennæ. In some they stand only a little out from the head, as in the grasshoppers; in some they are so much raised, that one would think them attached to the head, only by an articulation; such are those of the small dragon-flies.

The number of eyes in insects is not uniform; the greater part have two, but there are some that have five. Besides the two large net-work eyes, a number of insects have three others on the forehead. Spiders have generally eight eyes, but they are not disposed in the same way, in all the species. Those spiders, however, must be excepted, which have long legs, and antennæ resembling the claws of a crab, for they have but two eyes. Those of some insects resemble two hemispheres, elevated on the two sides of the head, consisting of a vast number of small hexagons like the cells of bees. In each of these hexagons are circles like lenses, which are so many eyes, increasing the power of that organ, to an infinite degree. By this apparatus, these insects enjoy, not only the advantages of sight, but have it probably clearer and more extensive than other animals.—This was, no doubt, necessary, on account of the rapidity of their flight, and to enable them to descry their food, while flying.

The eyes of insects are neither defended by bones, nor furnished with eye-lids to protect them from accidents: but to make amends for this, the external coat

coat is so hard, as to secure them from the dangers they would otherwise have to dread. I imagine, that the hemispherical figure of the cornea answers the purposes of the crystalline and other humours; and I believe that, in place of the different coats of the eye, each hexagon receives a particular branch of the optic nerve. The eyes of other animals are moveable, but those of insects, are for the most part fixed.

There is great art, and many things remarkable in the structure of the mouth in insects. There is almost as much diversity in the figure of this organ, as there are different species. It is broad, pointed, or long like the snout of a pig; and this last of various lengths and shapes.

Many insects have a sort of lips, not only on the upper and under side of the mouth, but at the sides. A great number have palpi at the mouth, by which they examine their food, and with which they introduce it, and they likewise use them for cleaning it. These palpi have several articulations, some have two, three, four, five, and even more. Some insects have only two palpi, others four. The extremity of them is often round and clubbed. It is channelled in some beetles, and oblong in others.

We find also, in the mouth of insects, a sort of jaws or pincers, (*mandibulæ,*) which serve instead of teeth. These they use in comminuting their food, or in breaking other substances. But, though these instruments are exceedingly fine and delicate, they are at the same time very hard and strong. They are so sharp that some can pierce the hardest wood, and make holes for themselves to live in. Those who live only on soft substances, have no use for teeth so hard or so sharp; accordingly, they are observed to be blunt in some beetles that live on rotten wood,

wood. Thefe pincers, in fome infects, are exceedingly fmooth and fhining; they pretty much refemble the fpur of a cock, as may be feen in the larva of the Hemerobius. Some have fmall teeth on the fide of thofe parts which form the pincers, and oppofite to one another. They are not broad like thofe in man, but pointed and curved, nearly like the teeth of a faw. Their number is not equal. Beetles have two: Scolopendræ three, and the larvæ of dragon-flies fix. The maxillæ of fome infects have at their bafe two fingular knobs, with a longitudinal recefs, into which the maxillæ can be folded, like the blade of a clafp-knife. When the infect would feize any thing, and for that purpofe joins the two pieces of thefe pincers, they do not touch, in fome infects, except at the points; in others, which have them longer, they fold over each other.

Thefe pincers are of great ufe to them; ferving them not only inftead of teeth, in breaking and comminuting the food they take, but for grinding many other fubftances, according to their neceffities. It is with thefe they feize their prey, and hold it faft. They are likewife arms both offenfive and defenfive. Thofe which make holes in the ground, employ them in removing the things that obftruct their progrefs.

There are fome infects of prey, (for they well deferve the name,) which, befides thefe pincers, have, at the mouth a fort of claws, with which they hold their booty, as birds of prey hold theirs with their feet. Others likewife have jaws *(maxillæ)* fituated under the pincers, which are moveable, like them, but in a lefs degree.

I muft not in filence pafs over the trunk, or, as others call it, the tongue of infects. Some, as the grafshoppers, carry it between their pincers. There are

are fcme that can extend and draw it in at pleafure The Lepidopteræ roll it up very adroitly, between two bearded bodies that conceal and protect it: others place it along their abdomen, where there is a little furrow formed for its reception. This trunk is not always of equal length: fome have it very fhort, and fome longer than the whole body. When it is viewed through a microfcope, it is found to be very curioufly fabricated, and, in a manner, adapted to the way of life of the particular infect: All its parts are fo difpofed, that nothing is fuperfluous, nothing deficient. In fome, it is inclofed in a fort of fheath, which terminates in a very acute point, ferving to pierce the fubftances that contain their food. When they have done this, they open the fheath, and infert the trunk into the wound, that they may extract the juice. It ferves, therefore, as a fyphon to fuck the fluids they ufe as aliment. And befides this, it ferves to prick, and to wound like a lancet. Though this trunk is fo fmall that it can hardly be perceived, except it be with a glafs, it is, neverthelefs, fo hard, that it can pierce, without difficulty, the hardeft and thickeft hide.

After the head, there follows the neck, the thorax and laftly the abdomen. The thorax is more or lefs hard in proportion as the habits of the infect expofe it to a greater or lefs degree of attrition. Thofe which creep into clefts as the Cimices, have this part of the body fomething flat, that they may the more eafily penetrate. It is more rounded in others, and fome, like the Silphas, have it furnifhed with elevated margins, occafioning a pretty confiderable correfponding furrow. The thorax in fome terminates in a point behind, and that of others is blunt or rounded, as in grafshoppers. Many have it fet with hairs, and others with minute elevations which defend it from the effects of violent friction. It is furmounted

ed in ſome with a protuberance, with two angles, with a horn, or with bodies of a pyramidical or rhomboidal figure.

In the abdomen of inſects there are many things which merit attention; and in the firſt place thoſe inciſures from which theſe animals derive their name. Theſe are called rings or articulations; they are formed with great art, and very much differ in appearance. Some are very cloſe, and look like wrinkles, others are broad and long: ſome are ſquare and ſome are furniſhed with a margin or rim; and often there is an opening diſcoverable between the folds. All inſects, as may be eaſily imagined, have not the ſame number of theſe rings. Some have five, ſome ſix, and ſome ſeven; all caterpillars have ten, and the aphides of the cabbage twelve. Some Scolopendræ have twenty, ſome forty or fifty, and a certain larva of a Tenthredo ſeventy-two.

Theſe rings are of eſſential uſe to inſects. It is by extending and contracting theſe that they move. By contracting them they defend the delicate parts of their internal frame from the heat of the Sun, from rain and from wind. If they need heat or refreſhment, they can procure either the one or the other by the dilatation of their rings which then allow a free paſſage to the rays of the Sun, or the freſh air. As they can dilate themſelves at pleaſure they can receive the preciſe quantity of either they have occaſion for.

There is ſuch diverſity of figure in the bodies of inſects and they are ſo wonderfully formed that an exact deſcription of them would be impoſſible. The body of ſome, as the ſpider, is of a ſpherical ſhape, that of others as the cocinella, is hemiſpherical. Some are round and flat, as the pediculi of the bat, others

are oval; some have the figure of an egg compressed, and some resemble the quill of a feather. Some have the body flat and square. The body of the insect called Hippocampus has four long and flat sides; that called the Coreulum aquaticum is of the figure of a heart. Some are crooked like a hook, and are furnished with a long tail, or small bag at the posterior extremity; of this last the Sphex sabulosa is an example The diversity of colour in this part is not less remarkable, but we shall enter more minutely into this subject hereafter.

Those insects which have no feet have in different places of their body, small points which serve instead of them; and with these they attach themselves to solid bodies, and keep fast to them. In horse dung there is to be found a maggot about an inch in length, whose body has nearly the figure of a cherry-stone. This animal has six rings by means of which it can elongate and contract itself like the pipe used in some places for decoying quails; the surface of each of these rings is garnished with small acute points; in such a manner that when the maggot chuses to raise them up, they penetrate the bowels of the horse, and keep the insect so firm, that it is not carried along with the fœces.

The bodies of those insects which live in water are naturally covered with a sort of oil which prevents the water from adhering to them, and retarding their motion. Others have along their body smooth or crenulated margins, sometimes knobs that not only serve to preserve them from being hurt by attrition upon entring or going out of their holes, but also are an ornament. These are not quite so large as a grain of millet, yet there is observable an assemblage of the most beautiful colours, and they resemble those little glass balls filled with different coloured.

loured waters. Lastly some like the camel have a protuberance on their back.

But we shall find as much diversity in the parts that remain as in those we have already mentioned. The extremity of the abdomen is not alike in all. Some have it smooth, in others it is set with hairs, longer or shorter according to the uses they are destined for. In this place are situated the papillæ from which they draw the threads they use in their different webs. Some like the caterpillar of the Phalæna bucephala have this part covered with a short of shield. Others have at the same place a stiff membrane which assists them as a rudder to turn when flying to this side or that; and is to insects what the tail is to birds. Some have long slender bristles, one, two, three, or four; and others a sort of horns, straight, bent or crooked in various insects. When these horns are touched, some like the caterpillar of the Sphinx Euphorbiæ can draw them in as snails do theirs. Others have more slender horns, either simple, or, as in the Blatta orientalis, articulated. These horns are of various use, for to some insects as the Gryllus campestris, they give intelligence when any thing approaches them from behind, to others they are the organs of attachment to solid bodies, to others of progressive motion. The extremity of the abdomen is likewise the situation of the sting in those insects which possess it; some have one, others two, which serve as weapons of offence or defence. Some, as the Earwig, instead of a sting have a sort of pincers or forceps at the tail, with which they defend themselves, and seize their prey. Lastly some like the caterpillar of the Phalæna Vinula, have two tentacula, like a two-pronged fork.

I now come to the parts of generation in insects, which cannot be passed over in silence. These are

 generally

placed at the extremity of the abdomen in the males, though there are some that have them placed forwards under the belly. These parts in proportion to the body of the insect are larger in some than in others. Those of the females are situated, as in the males, generally towards the extremity of the abdomen, sometimes under it. They are covered with a fine down, that the male organs, which are exceedingly delicate, may not be hurt by the contact.

Some insects have likewise, at the extremity of the abdomen, a sting. In some it lies within the body from which they can dart it forth when they have occasion to use it, in others it is altogether external. If short, it is placed under the belly, where it lies in a groove like that which receives the edge of the blade of a pocket knife. If long it sticks out behind, and is enclosed in a sort of case formed of two very slender laminæ like a tube cleft longitudinally. This tube terminates in a very sharp point, which opens to allow the sting to pass when it is used. This sting is bearded with very sharp points like the beards of a hook. These not only prevent the sting from being withdrawn, but make the wound more painful. It is formed of two sharp spears, which, being once inserted into the skin, penetrate further by means of their sharp points. At the base of the sting near the belly is found a small bag full of a strong and penetrating fluid. This the insect extracts when it has occasion, and injects it into the wound made by the tube of its sting, when tumour and pain succeed in consequence of the fermentation of this fluid. The tube of the sting is smooth in some, in others when viewed through a magnifier, it appears hairy. At the base of the sting in the abdomen of the insect are found the muscles by which it acts.

All insects do not make the same use of the sting. In

In the female for inſtance, it is the conduit through which the eggs are conveyed and depoſited. It is often more than half an inch in length, hollow, and cleft in two: It terminates in a pointed knob, with which the inſect makes a hole in the earth, or in a leaf large enough to hold her eggs. Theſe ſhe depoſites, through the hollow of her ſting, that the rugged earth or other matters may not harm them. As it is open by means of the cleft at top, as well as at bottom, and as the eggs do not deſcend by the preſſure of the air, Nature has formed in it many half rings oppoſite to one another, which facilitate its deſcent. Inſects contract theſe ſucceſſively, beginning with that neareſt the abdomen, and making the eggs deſcend from one ring to another, by a ſort of periſtaltic motion. The cleft of this canal is almoſt inviſible while the inſects are alive, but it opens a little more when they are dead. The ſting of the female is incapable of wounding; that of the males alone has this power.

The females of all inſects are not provided with ſuch a conduit: thoſe which depoſite their eggs on the ſurfaces of bodies, diſcharge them immediately by the genital organs. None but thoſe which depoſite their eggs in the fleſh, in other inſects, in leaves, or in the earth, have occaſion for ſuch a tube, that they may introduce them as deep as is neceſſary.

Although the ſting of the males is extremely fine, it is, nevertheleſs, ſtrong enough to pierce hard ſubſtances, and I have been ſtung by a bee through a goat-ſkin glove. They uſe it as a pike or lance to annoy their enemies, or to defend themſelves.

This tube or ſting does not always ſerve as a channel for the eggs. There are ſome aquatic inſects, ſuch as the Nepa Cinerea, that have this part common

mon to both sexes, and which they use as a spiracle to inhale the fresh air. They are seen often pushing the extremity of it to the surface of the water, and when they descend, there rise little bubbles of air, which escape from them.

We have had occasion to remark above, that insects which have feet, have not always the same number of them, but that they vary according to the different species. Those limbs are generally situated under the abdomen: we find, however, a particular order of insects, aquatic as well as terrestrial, that before their transformation, have their feet on the back. But no sooner have they divested themselves of their skin, and their feet, and are in a capacity to fly, than these appear under the abdomen.

All insects have not the legs of the same length. Some have them very short, with but one articulation. Such are all caterpillars, whose six fore feet, are not, strictly speaking, any thing but hooked points, and the eight hind feet have but a single articulation, which gives them the appearance of being mutilated. Some insects are likewise found that have them longer, with three articulations, as some spiders, mentioned by Pliny; four, as the Scolopendra morsitans; five, as in the Tipula motitatrix; six, as in the Aranea Diadema: and sometimes, even eight. The feet of the same insect are not always of equal length. The hind legs of most are longer than the rest.— Bees have them so long that they can carry them to their head, and put into their mouths the wax these legs are loaded with. This rule, however, is not so general but that there are exceptions to it, the fore legs in some being the longest.

These legs are generally composed of three parts, the first is a kind of thigh, *(femur.)* It arises immediately

mediately from the abdomen, and is thickeſt at its origin, although there are ſome inſects which have it thicker below than above. The ſecond is the leg, properly ſo called, (*tibia.*) The articulations of theſe parts in ſome inſects are furniſhed with ſtrong and ſharp ſpines. The third part is the foot, (*tarſus,*) which deſerves more attention than the other two.

It is generally articulated, the parts ſometimes round or heart ſhaped. Some have two articulations, ſome more, the length of five. At the extremity of theſe, ſome have two hooked appendices, by which they attach themſelves to the moſt poliſhed ſubſtances.— Between theſe, others have ſomething like the ſole of a foot, which enables them to ſtick to places where the hooks would be uſeleſs. It produces the ſame effect as the bit of moiſtened leather which children preſs upon a ſtone; it adheres ſo ſtrongly, that a very heavy ſtone may be lifted by it. Some have a ſort of cup at the knee joint, by which they affix themſelves ſtrongly to the bodies they want to hold by.

The legs of inſects likewiſe ſerve various purpoſes, and chiefly for walking. But there are ſome which uſe them merely as hooks for faſtening themſelves to objects, others for leaping. The leaps they make are ſo great, that it is ſaid a flea will leap 200 times its own length. For this purpoſe, theſe inſects are furniſhed, not only with ſtrong and flexible legs and thighs, but with vigorous muſcles, endowed with a power of elaſticity, which raiſes the animal high in the air. The feet ſerve as a rudder to thoſe inſects which ſwim, directing them to the place they want to reach. They hold in equilibrium, the body of thoſe that fly, and direct it at the pleaſure of the animal. They receive the ſame advantages from them that ſtorks do from their long legs. They ſtretch them out from the abdomen, and uſe them as

a rudder to ſteer them. Others, which are ſhort-ſighted, uſe them for exploring the road, both before and behind them. Some employ them in cleaning their eyes, their antennæ, and their wings, and in clearing them of the duſt and earth which might incommode them. Thoſe which dig in the earth, uſe their legs as pick-axes, to make cavities and ſubterraneous paſſages. As men uſe their arms, and ſome animals their feet, as weapons of defence, there are inſects which make the ſame uſe of theirs. I believe I have already mentioned that ſome uſe them for ſeizing and holding their prey. Laſtly, by the ſtructure of the legs, the ſpecies of inſects are often diſtinguiſhable.

The wings are the principal things to be noticed in winged inſects. I have already ſpoken above of the number which the different kinds of inſects poſſeſs; and have obſerved, that ſome have two, others four. They are ſo delicate, and their ſtructure diſcovers ſo much art, that they may well paſs for one of thoſe objects that moſt clearly demonſtrate the wiſdom of the Creator. They are provided with different nerves, which, like thoſe of leaves, are diſtributed in different directions. The poſition of them is alſo different, in different inſects. In ſome they are horizontal, in others they decline a little towards the ſides, and in others, they ſtand erect. The remarks which I have had occaſion to make in ſome of the preceding articles, ſufficiently ſhew, that the wings of inſects are very various. Some have a kind of a covering over them, while others are bare. Some of theſe laſt are exceedingly thin, ſhining, and tranſparent, like parchment or fine gauze; others are opaque, and covered with a ſort of farina or powder. I have alſo already examined the different ſorts of butterflies and winged beetles, ſo that I have only here to treat of the wings themſelves.

The

The wings of insects, which are bare, whether they have two or four, are exceedingly thin, and their nerves are ramified in different directions. In some, these ramifications extend from the body to the half of the wings only, where they are lost and disappear, as in the Hippobosca equina. In others they reach the margin of the wings, where they join and form a spot, which Frisch calls the marginal spot, as in the Hemerobius Chrysops. These ramifications assume various figures. Sometimes they are squares, which, at the superior extremity divide into three branches, as in some Libellulas, in others they are rhomboidical, as in the grasshoppers, pentagonal, or irregularly pentagonal, as in the Sphex sabulosa: the membrane that fills up the interstices of these nerves is so thin, that it can hardly be perceived, and the whole wing appears like thin gauze.

There is great diversity in the figure of the farinaceous wings. They may be compared to the leaves of different trees; whatever connection there may be among them, there is not one of them like another. They are round, long, heart-shaped, indented, or intire in the margins, oval, or nearly oval, their ends terminating in a point; in others they form triangles, the ends being either pointed or rounded. The margin of the wings is often indented like the edge of a saw, or undulated, forming semicircles like the figure of a serpent in motion; and sometimes between these circles there are small elevations. Some at the extremity of the wings have a sort of tail, like that of a swallow, some have it ornamented with fine fringes like lace.

When the dust which covers the wings of insects is looked at with the naked eye, one would take it for nothing but fine farina or powder; but, if it is seen through a magnifier, this pretended dust appears

in the form of very delicate feathers, which easily come off on being touched. The small feathers are of very different figures; some have the form of a a battledore with a short handle, others are almost oval, except at the base, where they are a little notched; some are like the leaves of a willow, except that they are sometimes indented at top: some resemble a fan, a square with rounded angles, but waved at top; others are pointed at the base, and enlarge gradually, terminating in two, three, four, and even five long points like a finger; some resemble the heart-shaped leaves of trees, and terminate in two or three hooked points; others are oblong, and pointed at their origin, where they are oval, and have at the extremity, three, four, and even a greater number of short points; lastly, some are long, thickening at the base, slender in the middle, and are twice as broad at the top, as at the bottom.

Without taking into account, the different colours of these wings, of which we shall hereafter take notice, many are marked with singular characters. On the wings of some, are marks which resemble Hebrew letters, on others a Roman C, a Greek upsilon, a V, or an O. Madame Merian observed, on the wings of a butterfly, characters resembling the letters B C Y M; this I have not myself seen. Others are marked with a St Andrew's cross, and some with the figure of an arrow.

The wings that have cases are not less worthy of attention than the others; these cases are hard as horn, and are easily broken. They are like a sheath to the delicate wings, which they cover and preserve from injury. As insects have no bones, these serve instead of them externally. They are not of equal hardness in all insects, the genus of Cantharis has them thin and flexible, and Frisch says of the Cantharis

ris fuſca, that when it dies, the elytra ſhrivel up. There is likewiſe great diverſity in their length; in ſome, they cover only a ſmall part of the body below the thorax, in others they cover the half of it; in ſome they hardly reach the extremity of the abdomen, in others they cover the whole of it. Sometimes theſe caſes are nearly opaque, and hard as horn; in others thin and nearly tranſparent. Not leſs variety is obſervable in their ſhape. Some, when joined together, are round, like the ſection of a ſphere, others oval, oblong, or ſtraight. Some are exceedingly ſmooth and poliſhed, others have a border, or are dotted with little depreſſions, as if made with a pin. Some have longitudinal lines like the furrows of a ploughed field, and others are ſet with hairs, or adorned with little tubercles, covering the ſurface.

The wings to which theſe caſes ſerve as covers are very fine and tranſparent. In ſome ſpecies they are not longer than the caſes themſelves and may be covered therefore without being folded. But there are others which have them much longer, and muſt fold them up when they are not flying to put them under the elytra. For this purpoſe they have at the external margin an articulation or a kind of ſpring to fold up what is longer than the caſes. When theſe wings are laid on the back, their largeſt nerves are without ſupport, and the two ends which are too long hang down. But when the elytra are laid down to cover them, they lower at the ſame time theſe nerves, and then the two ends drawn by their muſcles are folded in, and take their proper place. In order to accompliſh this, the beetle has nothing to do but to leave a ſmall ſpace between the elytra and abdomen that what remains of the wing may the more eaſily be folded: and this happens with all

those crustaceous insects, whose wings are longer than the elytra.

Many species of insects are covered with hairs; sometimes these are so fine that they escape the naked eye, and are visible only with a good glass. But in others they are sufficiently obvious. They do not cover the whole body: some have them on the head where they look like a plume of feathers, some on the thorax, on the extremity of the abdomen, on the wings, both upper and under, and on the legs.

These hairs are of different colours which change however when the insects grow old, and are about to form their cone. They are thinly scattered on some, on others thickly set. There are also insects where the hairs form tufts, like a brush, (*fasciculi*) as in the Phalæna pudibunda; some square, others round, often equal at top as if cut over like the egrets in the turban of a Turk, and often terminating in a point like a pencil. Sometimes the hairs are so gross and strong that they may justly be called spines; each of these spines sometimes dividing into many rigid branches, and so small as to be with difficulty seen. They too are of different colours, as may be seen in the different species of the thorny caterpillars and the number of their branches varies, some having three, four or more. Their position is also very different. In some the spines are placed round each ring in one line as in the caterpillar of the Papilio Io; in others they are placed in two lines, not opposite to one another but alternate, and always at such equal distances, that one would say they had been measured with the greatest care; an instance of this may be seen in the caterpillar of the Papilio Urticæ.

These hairs and spines answer more than one purpose. They preserve some from two great friction which

which could not but injure their ſkin; they are likewiſe weapons of offence, others ſtriking their enemies with them very forcibly. Laſtly, in thoſe that live under water, there are ſome that encompaſs their hairs with a bubble of air which ſerves them to come up more eaſily to the ſurface. The water beetles have hairs on the belly between which there are little particles of air. When theſe are numerous they deſcend to the bottom with difficulty, and when they reach it, they are obliged to hold by ſome ſubſtance to keep themſelves there: but when they looſe their hold, the air carries them up to the ſurface.

Nature has endowed ſome inſects with horns different from the antennæ, having no articulations. Some have but one placed on the head, and riſing ſtraight or recurved like a hook. Some have two placed on the forehead bending to the ſides or riſing in a ſtraight line. Theſe horns are either ſhort, ſmooth, or a little incurved like hooks, or branched like thoſe of the flying ſtag. Sometimes they are of equal length, ſometimes one is longer than the other. There are likewiſe inſects which have three of theſe horns riſing perpendicularly. They are not always ſituated on the head, but ſometimes on the ſhoulders near the head. Laſtly, in ſome inſects they are immoveable, but moveable in others. Theſe laſt can by their means hold their prey as with pincers, and the former can remove any obſtacle from their way.

CHAP. II.

SECTION II.

OF THE INTERNAL PARTS OF INSECTS.

LET us now come to the internal parts of insects, and let us scrutinize the inmost recesses of their structure in order to penetrate into the mysteries of nature. The task is full of difficulty. Many of those parts are so small as to escape our sight. To discover them we must use the highest magnifiers. Besides, the eye is weakened by the continued contemplation of one object, and we feel this sensibly when we force ourselves to the task. Notwithstanding these difficulties, however, Naturalists have discovered many things on our present subject; these I shall detail, and add what I have learnt from my own observations.

If we separate the external skin from an insect with instruments, or throw it into warm water, that the skin may come away of itself, we shall find that it covers many parts worthy of attention. And first in the head we discern the brain, the substance of which is so soft that it is not easily examined even with a glass. When we pierce the eyes of insects with a pin there issues out a fluid, in some clear like water, in others red like blood. Under the skin is the flesh. It may well receive the name since it consists of fibrous

rous

rous parts soft and sometimes reddish as in other animals. The fibres are oblong parts, thin and slender like the finest thread; their use is to connect the other parts with one another, and to put them in motion. They resemble wrinkles in the form of rings, and are distinctly observable in insects when the muscles are inactive; but when these are in motion they stretch the fibres, and make them invisible. The excessive delicacy of the fibres in insects has prevented hitherto our discovering whether they are enveloped with a fine membrane, like those of quadrupeds. In some insects these fibres are so short that their length is hardly equal to the breadth of three hairs; and therefore, they are not always to be seen, even with a glass. As they serve to extend, and to contract the muscles, their structure must resemble that of a wire wound round a cylinder, when that cylinder is withdrawn. They vary their motion, folding themselves in a semi-circle, sometimes to the right, sometimes to the left, nearly like a number of small worms. This motion, however, is very inconsiderable, and the fibres hardly change their situation. After these, the flesh of insects appears, as in other animals. There are likewise small veins, which, joined to the nervous and fleshy fibres, compose the muscles.

Insects are destitute of blood, properly so called; because, the composition of that substance demands more preparation and elaboration than can be performed in a body so small as theirs; but, in place of blood, they have certain viscid humours that serve the purposes of it. These humours contain their animal spirits, and from them insects draw their nourishment. However subtile they may be, they are, nevertheless, endowed with considerable tenacity. In consequence of this quality, the head of a fly, after being cut off, will adhere again to its body, if stuck

on,

on, without, however, restoring it to life. This glutinous quality of the humours enables insects to live for a time, after having been cut into two or more pieces; it prevents a rapid evaporation, it retains the humours which still continue to circulate for a time in the members, which would not happen without this quality. And, that this quality actually resides in the humours of insects, we may be convinced, by exposing them, when drawn from the animal, to the air, when they will so dry, in a few minutes, as to become brittle like glue.

Insects have an artery, which is observable, running along their back, and in which pulsation may be seen. The air produces in this artery the same effect that blood does in circulation.

Insects eat and drink like other animals, a stomach is therefore necessary to them. This is nothing but an extremely thin and hollow bag. The aliments of insects pass from the gullet into this stomach, where they are digested and changed into a nutritive juice. Among quadrupeds, those that ruminate need more than one stomach, formed of several folds. It is the same with insects; some of them are found to ruminate, and consequently, have more than one stomach. It is of this sort of insects that God permitted the Jews to eat. See LEVIT. CH. xi. 21. and 22.

Many persons, not having observed a heart in insects, have denied that they have any: but this is rash. These animals have many parts, so very minute, that they cannot be discovered; may this not be the case with the heart? Besides, there are many species, in which this organ may be distinctly seen. Lastly, the humours circulate in insects, and the arteries have a sort of pulsation; they must, therefore, either have a heart or something analogous to it.

Lungs

Lungs have likewise been denied to insects. But, as respiration is necessary to every creature, and as it is carried on by means of lungs, which are found in all the other animals, we cannot doubt but insects have them likewise. They are not of the same size, nor the same structure in all creatures; and those of insects are larger, in proportion, than those of other animals. This organ is formed in all, of little vesicles, connected with one another. The air enters by the trachea, and goes out at the same place. Insects likewise have a trachea, which terminates in their lungs; but it is not of the same structure with that in other animals. In these last, it is formed of many cartilaginous rings; in insects it is nothing but skin, which can be dilated or contracted with ease. The lungs of other animals have branches, which, from the vena cava, disperse themselves through the substance of the lungs, in many smaller branches. Insects have the same, and by means of these, the air is distributed to all their members.

In most insects, the intestines are a little different from those in the other animals. The minuteness of their bodies will not admit of so great a number. Accordingly, in many we find nothing but a tube, extending from the mouth to the vent, as may be seen in such as are transparent. It would appear, however, that, with respect to the great gut, it is not in all of the same figure, for the excrements of some caterpillars are round, or cylindrical, and those of others have five furrows. This could not happen but from the structure of the rectum, which is the mould that gives the fæces their figure.

Round this long tube, are many slender fibres, which answer the purpose of veins and windpipe.

Bees have, towards the extremity of the abdomen

a refervoir, which other infects have not. In this they depofite the honey which they have collected from flowers.

In the laft place, it is to be remarked, that the females have an ovarium. This organ feems formed of a mafs of fibres, which undoubtedly are veins.

What I have now obferved, with regard both to the external and internal parts of infects, proclaims, in the moft explicit manner, the wifdom, and infinite power of the Creator. When we affift at the diffection of any of the larger animals, with what admiration does not the fight affect us! the different members, their figure, the mufcles, the arteries, the veins, the lungs, the nerves, the bowels, every thing furprifes and aftonifhes, for every where we difcover the great and the wonderful; but the bulk of thefe animals is fufficient to contain fuch a variety of parts, and we are not furprifed that they fhould find room there. What then ought to be our furprife, when, in diffecting the minuter infects, fuch as we are able to diffect, we difcover the fame members, the fame parts as in the moft enormous quadruped! What difplay of greatnefs, of wifdom, and power, in fuch a heap of parts, all equally perfect, and comprifed in fo fmall a fpace! Should the moft fkilful artificer attempt to work on the fame defign, he might perhaps imitate the external parts of the larger infects; but how would he fail, in forming the fmall internal organs! Could he give his machine the power of fpontaneous motion! Could he communicate to it the power of propagating its like? All this is beyond the power of the moft able workman, and can be performed, only by that infinite wifdom and power, which is the attribute of the Creator alone, the firft and fole caufe of all exiftences.

We

We ſhall be the more convinced of this truth, if we obſerve the wonderful order and arrangement of ſo many parts. In the animals, different from inſects, the head, the eyes, the forehead, the mouth, the teeth, the tongue, the breaſt, the belly, the feet, &c. have each a particular place aſſigned them: is it not the ſame in inſects? A few worms alone are deſtitute of breaſt and feet. But not only are the members ſituated in the places moſt convenient for them; the ſame arrangement is obſervable, in the different parts of which each of theſe members is compoſed. Does not an order ſo perfect announce, that the author of it is a being infinitely wiſe? If this regularity were obſervable only in ſome of his creatures, if the propriety of it were doubtful in others, there would be ſome appearance of reaſon, in ſuſpecting, that the wiſdom of the Creator was not perfect; but it is univerſal and invariable: it is ſeen in the diſpoſition of the members in man and quadrupeds; in the feathers of birds; in the flowers of plants; and in all the parts, both external and internal, of the moſt loathſome inſects.

But the diverſity obſervable in all theſe members, is a circumſtance not leſs worthy of admiration.—Though their number is vaſt, yet there is not one that reſembles another; they all differ, either in figure, in dimenſions, or in ſome other character. How boundleſs muſt that imagination be, which could form the plan of ſo many different parts, and diſpoſe them all in ſuch perfect regularity! When we enter a town, in which all the houſes are diſpoſed in ſuch a manner as to form one regular plan, we naturally conclude, that ſome perſon ſuperintended the building of the town, who had judgment to plan it, and power to reſtrain the inclination of individuals from building every one according to his fancy. If, notwithſtanding the regularity of each particular

edifice, it ſhould be obſerved, that they differed very much from one another, we would not fail to conclude, that the architect was poſſeſſed of an inventive genius, capable of imagining many plans, ſubordinate and ſubſervient to the general deſign. But how great is the difference, between the moſt perfect arrangement of a town, and that of the members of the ſmalleſt inſect! How inferior is the genius which can, with a diverſity in the parts, preſerve the unity of the whole, only in a ſingle thing, to that which can do ſo always, and in a multitude of different deſigns! The former exerciſes fancy and taſte only, in the conſtruction of a town, the other exerts both, a million of times, in the ſtructure of an infinity of the moſt different objects. An artiſt, who deviſes various figures for the embelliſhment of his work, exerciſes his imagination, and diſcovers genius; and, if he executes what he has conceived, he then ſhews, that he is poſſeſſed, at the ſame time, both of power and freedom. But how great is the diſtance between the moſt perfect imagination of the ableſt artificer, in beautifying his performance, and that which the Creator hath diſplayed in decorating inſects! Surely the deduction from theſe reflections is clear and natural, that inſects have been formed by a Being, ſupremely free, infinitely wiſe, and all-powerful.

The diverſity which I have remarked in the numbers of inſects does not in the leaſt prevent them from poſſeſſing the moſt perfect harmony and proportion. We ſee plainly that the body, the head, the legs, the wings of each ſpecies have been made for one another; and deſtined to form one whole. None of theſe limbs interrupt the motion of another; on the contrary, they co-operate together, and thus facilitate the tranſportation of the whole from place to place. The internal organs are formed in ſuch a way as to diſtribute the food eaſily to every part of the

the body. We find all the vessels necessary for the secretion and distribution of the nutritive juices, and for the excretion of what is superfluous, which would otherwise prove hurtful. Can all this be the effect of blind chance? Is it possible that any thinking being can harbour so extravagant a thought? Is it not more agreeable to reason to attribute the cause of a structure so wonderful to a being infinitely wise, and infinitely powerful? What other, not absolutely perfect, could fabricate a machine which displays so many characters of wisdom and power? What other could have bestowed on each insect that exact quantity and proportion of members that are necessary to fit it for the manner of life it is destined to? How could chance give feet to those that run and wings to those that fly, and have to seek their food at the top of the highest trees? How does it happen that chance never mistakes on this head? We find constantly, and without exception, that those insects which are obliged to seek their food in distant places, have the organs of sight and smell so keen and delicate as to discover that food afar off; but the sensibility of these organs would be useless to them without the power of motion: and accordingly they are furnished with wings fit to carry them to a distance. Those which are obliged to creep into openings in the ground, have their bodies adapted to the purpose, by being furnished with an oil which facilitates their passage: and they have the apparatus proper for opening it, if it should be hard. Those which live in more solid substances, as firm earth, roots, wood, &c. have likewise what is necessary for their way of life; their skin and wings are so hard as not to be injured by attrition. We must therefore return to our first conclusion: A Being all powerful and all-wise is the Creator and Preserver of insects. This is the only way in which we can sufficiently account for all these wonderful phænomena.

CHAP. III.

CHAP. III.

Of some singular qualities in certain Insects.

In the number of ſingular qualities belonging to inſects I put the ſmallneſs of ſome of them, which, not only in compariſon with other animals are exceſſively minute, but even in compariſon with one another. There is a ſpecies of ſcorpion, one eighth of a yard long, and Buſbequius aſſures us that he ſaw in Turkey an ant from the Eaſt Indies as big as a middle ſized dog. Theſe inſects are very large in compariſon with moſt others, and eſpecially with thoſe which are no larger than a grain of millet, the point of a needle. or which are even ſo minute as to be imperceptible, except with the aſſiſtance of a microſcope. What can the naked eye take in leſs than the cheeſe mite? And yet this inſect has a head, joints, muſcles, antennæ, hairs, inteſtines, &c. Thoſe parts of cheeſe which it feeds on, muſt be ſtill more minute. How fine muſt be the nutritive juice, which circulates in the veins of ſo ſmall an animal! From this circumſtance alone we might infer the infinite diviſibility of matter.

Some inſects ſhine in the night like fire. Nature hath produced certain bodies endowed with an innate property of giving light. This light is lively and brilliant in ſome, as it is ſeen in ſunſhine. In others it is weaker, and ſhines only during night, the great light

light of day effacing all the rays it is able to send out. Thus the hairs of horses and of cats especially of such as are black, if they are rubbed in the dark, give out sparks, or a small evanescent light. The rotten wood of the willow, fish, and some other substances likewise shine in the dark. Thus too certain insects, whose light is not sensible during the day, but when night comes they shine like burning coals, stars, or lighted matches. The light of some is so clear that it serves instead of a candle in some places, as in Brazil, by the help of two or three of them the people can see to sow, spin, and even to read. By their assistance also persons travel by night; they are a flambeau that shews them the way, and prevents them from wandering.

The greater part of insects are dumb; however many have organs proper for making a kind of noise, or producing a certain sound. There is as much variety observable in this noise and this sound, as there is in the voices of different animals. Among birds, the nightingale sings sweetly, the crow croaks, the swallow twitters, the owl shrieks, the turtle cooes, the magpie chatters, and the quail and the snipe have each their particular note. The same difference takes place among quadrupeds: the lion roars, the ass brays, the horse neighs, the ox bellows, &c. the same is observable among insects: Those which gnaw wood produce a sound similar to that of the movement of a watch. The different strokes they give are so justly measured, and are heard one after another, at intervals so equal, that one would almost take it for a clock; and some have the tinkling sound of a cymbal, or the stroke of a bow given behind the bridge of a violin: others sing, hum, give a sharp acute tone, &c. All however do not produce this sound in the same way; some make it by rubbing the nape of the neck against the thorax,

rax, others by the clapping of their wings against each other, or against the back, as the Scarabæus Fullo; nature has furnished the wings with very strong nerves for this purpose. Lastly, some produce a sound merely by rubbing their head, and the extremities of their wings with their long legs.

This sound is often very strong, especially when many insects fly together. That however is not always necessary; there are some insects whose voice is so sonorous and piercing, as not only to awaken people a-sleep, but to make itself be heard at a distance, even though they be under ground, as the Gryllotalpa, or at a pretty considerable depth in water, as a species of Dytiscus.

This faculty is bestowed on insects for different purposes; many males use it as an invitation to the females, and therefore, it is often a mark, by which the males may be distinguished, as I think I have already observed. This rule, however, is not without exception, for the females of the Cimex personatus, and Scarabæus Fullo, likewise utter a sound. The noise which some insects make, likewise serves to denote anger, sorrow, or pleasure. Some use it to inspire their enemies with terror, and to frighten them away. Lastly, it is often a mark, by which other animals discover their enemy, who, when they hear his voice, avoid him and escape.

Many insects discharge a sensible smell. This is sometimes so offensive, that, in approaching them, one is sometimes obliged to stop ones nose, but there are also some whose smell is very agreeable. The musk beetle takes its name from this circumstance. In some, the smell is natural to the insect, in others it is adventitious, and arises from the substances they feed on. Some do not perpetually give out this smell;

ſmell; to make them yield it, they muſt be ſqueezed, and the odorous particles, as it were, forced out of them. Some loſe, at the inſtant of death, the ſmell they had while alive.

This quality is of ſpecial ſervice to them at the time of pairing; by it they can diſcover one another at a diſtance, and can more eaſily meet. Like deer and cats, they diſcharge much more of the odorous effluvia, at this time, than at any other. Some uſe it to diſguſt their purſuers, in the ſame manner as the Indian animal does, called Yzquiepatl, (Viverra vulpecula.)

It has been obſerved, that inſects ſtain the leaves of trees, walls, and water. In the month of May, and other ſummer months, we often perceive a ſcum or green fibrous pellicle on ſtagnant waters. This is a ſort of web, made by ſmall maggots like eels, which the wind has driven from the ſides of the pond. Theſe ſmall animals are exceedingly laborious, for this ſmall pellicle is no ſooner removed, than they immediately weave another. There is a ſmall water inſect, (*Monoculus Pulex,*) which multiplies during ſummer, and its progeny are often ſo numerous, that they make the ſurface of the water quite red. This obſervation is of uſe; for the vulgar imagine, that the water is then turned into blood, and that it is an omen of ſome approaching calamity. There are other inſects that give occaſion to ſimilar ſuperſtitions. They diſcharge drops of a red juice, which aſſume different figures, and ſometimes that of a croſs. This is enough to alarm the ignorant, and to make them believe, that it has rained blood, whence they form all ſorts of diſaſtrous preſages. But perſons more attentive, and leſs prejudiced, have made experiments, and demonſtrated that the appearance proceeds from certain ſpecies of butterflies.

Peiresc, if I am not mistaken, was the first who took the trouble of examining into this phenomenon. In the month of July 1608, a report was spread, that a shower of blood had fallen: this struck him, and determined him to neglect nothing, in order to clear up a circumstance so extraordinary. He made the people show him those large drops of blood, and found them on the wall of the cemetery of the great church, and on those of the houses of the common people and peasantry of the whole district, for a mile round. He considered them attentively, heard all that was said on the subject, and, after mature deliberation he concluded that the shower of blood was an illusion. He had not, however, discovered the true cause of it, but an accident soon discovered it to him. He had enclosed, in a box, a large and beautiful chrysalis, and hearing one day a noise in it, he opened the box, and there immediately flew out, a butterfly, (*Papilio C. album*) leaving at the bottom of the box, a pretty large red drop. There had appeared at the beginning of the month of July, a great number of these butterflies; whence Peiresc concluded, that the red spots, which appeared on the walls, were nothing but the excrements of those insects. He was confirmed in his conjecture, upon examining the holes in which that species generally nestles. He observed besides, that on the walls of the houses, in the middle of the town, where these butterflies never come, there were none of those spots, nor on any but such as were next the country, where it is probable they might have lodged. Lastly, he remarked, that no spots were to be seen on the tops of the houses, but only from the middle story downwards, the height to which these butterflies generally rise.

Other curious enquirers have made the same observation since his time. Among these is Dr. Beckman,

man, professor at Frankfort on the Oder. In the month of July, 1665, being at Ochsenfurt, he remarked, that many butterflies discharged similar red drops when they were merely touched with the hand. Mr Linke of Leipsig informs me he has observed the same thing.

Insects make war on one another, and some, even on individuals of their own species. The large reddish yellow spiders eat one another, when put together under a glass. Grasshoppers are mortal enemies. The male lives apart from the female, except at pairing time: if the female meets the male by chance, she maims him, breaks his legs, or kills him outright. There is open and declared war among some species; the ichneumons, for instance, and spiders massacre each other reciprocally, with merciless fury. If grasshoppers are put in the same place with the house cricket, the former eagerly pursue the latter and kill them.

Besides natural antipathy, other reasons may be suggested for this barbarity. Insects, for whom the Creator has destined others as their food, lay snares for them, in order to satisfy their appetite. They therefore behave like a hunter, who endeavours to entrap the game he is in quest of; and, when they have seized their prey, they kill and devour it. Wasps, for instance, make war upon bees, by the same instinct which induces the wolf to attack the lamb, the cat the mouse, or the stork the frog. The want of other food induces insects to make war on one another, and puts them under the dismal necessity of devouring their own species. I have often made the experiment with certain caterpillars; they never attacked others, till they were entirely deprived of every sort of food. The horrors of famine drove them to do what men have sometimes done in

fimilar cafes, devoured one-another. Jealoufy is often the caufe of their fatal contentions; the male grafs-hoppers, and thofe of moft other infects, fight together for the poffeffion of a female. The ichneumons, which depofite their eggs in the bodies of caterpillars, and which, for this purpofe, pierce them deeply with their ftings, excite them by the pain to defend themfelves.

It is faid, that fome infects have an averfion, and natural antipathy to certain animals, and many examples of this kind are related. No fly, it is faid, ever enters into a houfe, where the head or tail of a wolf is fufpended. Scorpions have an averfion at crocodiles, fpiders at toads, and when thefe animals appear, they dart upon, and kill them.

Some infects are fubject to the ftone. It is not doubted, but that this is the cafe with fome fpiders; but the queftion is, whether the ftones can be found, and in what manner. Doctor Sennertus fays, that the infect muft be put into a glafs, full of Valerian root bruifed. Others fay, that it will be fufficient to put that root under their webs. However this may be, Doctor Simon Pauli being at Wittemberg, found a fpider, as large as a nutmeg, which he put into a glafs with the above mentioned preparation; but, contrary to his expectation, the animal yielded no ftone. From this experiment he concludes, with too much precipitation, that what has been faid of the ftone in fpiders, is a fable: for Doctor John Franck inclofed fifteen fpiders in a glafs, with the prefcribed precautions; they left there a ftone of an afh colour, with fmall black fpecks. This experiment fhews, that though all thefe infects are not affected with the ftone, fome are. Laftly, it appears from the mufæum of Olaus Wormius, that a Brazilian infect, called the fea loufe, which fucks

the

the fiſh called *Acarambitamba*, is ſubject to the ſame diſeaſe. Wormius himſelf had one of the ſtones.

The regularity obſervable in the different members of inſects, gave me an opportunity, in the laſt chapter, of remarking the infinite power, the wiſdom, and the liberty of the Creator. The ſubject treated of in the preſent, is a no leſs fruitful ſource of reflection. Man, accuſtomed to ſee the ſame objects every day, beholds them without regard; the moſt ſtriking proofs of the unlimited power and wiſdom of the Deity, make no impreſſion on his mind, when they become familiar to it. To draw him from his lethargy, he muſt be rouſed by ſome appearance extraordinary, ſingular or important. All Nature teems with inſtances of the power, the wiſdom, the goodneſs of God, which bear alſo a character of novelty: it is neceſſary, only to develope them, and to preſent them to the underſtanding. The ſingular qualities of many animals, and of diverſe inſects in particular, are of this number. It would appear, that the divine wiſdom has endowed them with theſe perfections, ſolely with the view of exciting our attention, and of elevating our minds to the contemplation of the wonders of Nature. The duty of a true Chriſtian is to conform to thoſe invitations, and to acknowledge, in thoſe ſingular productions, the power and wiſdom of a divine Author.

Let us fix our attention, in the firſt place, on the wonderful and almoſt infinite minuteneſs of many inſects. Becauſe they do not approach to the ſize of an elephant or a whale, or ſome other animal of great bulk, are they leſs the production of a divine hand? I own that theſe large animals are Coloſſuſes, and deſerve a marked attention; but inſects, thoſe minute inhabitants of the world, bear ſtill more admirable

admirable marks of power and wiſdom. Is there not more art diſcoverable in the ſtructure of the teeth of a Dermeſtes than in that of the tuſks of a boar? Is there not more beauty in the wings of ſome butterflies, than in thoſe of the peacock? How does the little excell the great, when we compare the head of a graſshopper with that of a horſe, the trunk of a flea, with the proboſcis of an elephant! Whoever ſhall reflect ſeriouſly on all this, will find that the powerful hand of the Creator is in every thing worthy of the higheſt admiration; that it is no leſs conſpicuous, to ſay no more, in the ſtructure of a mite than in the formation of a Behemoth. We admire the ſkill of a workman who can execute a piece of mechaniſm ſo minute as to be hardly diſcernible by the eye, and with juſtice. It is more difficult to make a chain ſo ſmall that a flea may be bound by it, than one fit to drag along a waggon; there is more dexterity required in moulding the figure of a ſmall fly than in carving the image of an elephant. Let us therefore admire with deep humiliation the wiſdom of God which is grand in great things, but which is not leſs ſo in ſmall. How great is the difference between his works and thoſe of the moſt ſkilful artiſts! We have already had occaſion to make the remark. Can they give to the maſterpieces of their hands thoſe internal organs by which the works of nature execute all their motions? Can they poliſh the external ſurface of their production ſo as to make them any way comparable to thoſe of the Creator? However poliſhed theirs may be, in compariſon with his they will always appear rough and rugged. Let us likewiſe compare the ſmallneſs of the things moſt artificially conſtructed by human hands, with thoſe ſmall machines endowed with life and motion. Let us compare them with the bodies of thoſe minute animals of which Leeuenhoeck diſcovered many millions in a ſingle drop

drop of water; and his discovery we cannot discredit, for many learned men after him have made the same experiments. Robert Hook, and many others assure us, that in one drop of water, of the size of a grain of millet, there have been discovered sometimes ten, sometimes thirty, and sometimes five and forty thousand of these animalculæ Do these owe their existence to chance? It would be ridiculous to suppose it; for chance cannot bestow a regular figure, nor arrange members in just proportion, nor confer the faculty of propagation. Shall it be said that they have been formed by other creatures? But have these that infinite power which is necessary for creation? Let it be our duty to acknowledge that no cause for their existence can be assigned but God alone. He who hath given the Sun its light to shine by day; he who hath commanded the Moon and Stars to enlighten the night, is the same who hath bestowed on certain insects, for certain purposes, the faculty of appearing luminous in the dark. The same Creator who hath given to man the power of speech, to quadrupeds and birds their different voices, has given to insects the power of producing certain sounds. He who hath given to musk its flavour, and to the animal we mentioned above, the power of disseminating its offensive effluvia, is also the cause of the different smells which exhale from the bodies of insects. In short, the same hand that hath impressed upon minerals, on fishes and on plants, the quality of yielding different colours for dying, is the same who hath bestowed the same qualities on different insects. And as we see that there is not one of those particular qualities but what is bestowed for some purpose, and a certain end, we cannot but acknowledge that the whole is directed by a wise being, who has formed one plan and pursued one design, and who hath executed the whole with perfect precision.

CHAP. IV.

OF THE BEAUTY OF MOST INSECTS.

NATURE furnishes every thing which can contribute to the gratification of our senses. There are creatures which it gives us pleasure to touch; we are delighted with the voices of others; there are some which exhale the most agreeable perfumes, the taste of some pleases our palate, and the beauty of many charms the eye. Insects, otherwise so despised, are well fitted to minister to our gratification in this last respect. I have had occasion, in some of the former Chapters, to treat of that particular beauty which consists in the just proportion and judicious adaptation of their several members. Not to fall into useless repetitions, I shall confine myself here to the beauty of their colours, to the skill with which they are arranged, to the delicacy of each particular tint, and in general, to the admirable disposition of the whole.

The brilliancy of those colours is particularly remarkable on their bodies and wings. It is true that we often find but one colour on the bodies of insects, but in some it is so beautiful and shining that it surpasses the finest varnish. Each part of the body has its particular colour, but all equally beautiful. I mean, for example, a certain fly, whose back is like polished

polifhed fteel inclining a little to green, and its abdomen is red like polifhed copper.

The body of moft caterpillars prefents a compound of different colours often mingled with fo much art that the moft fkilful workman could not imitate them in his moft gaudy ftuffs of filk, and convinces us that Solomon in all his glory was not arrayed like one of thefe. Some have the body marked with dots or points of different colours, or with fpots larger than the points, of unequal bignefs, and of irregular fhape; or laftly, with points and fpots at the fame time, varioufly but beautifully difpofed. The bodies of other caterpillars are adorned with lines, and bands of different colours, and of different figures: fome are longitudinal, others tranfverfe; fometimes continuous, at other times interrupted, as if they had been cut in different places. There are likewife fome that have lines longitudinal and tranfverfe at the fame time. In fome caterpillars the fpots take the figure of lozenges and rhomboids; in others that of bands, a little broader than the lines, which are either longitudinal or tranfverfe. There is often an agreeable intermixture of all thefe marks at the fame time. Some are adorned with lines and points, others with points and bands, and a third with points, lines, and bands, all at once.

The little tubercles of the fize of a grain of millet, or of poppy feed, which are feen on the body of many caterpillars, are no fmall ornament to them. Thefe fmall elevations are fo fmooth and fo polifhed, that when we look at the animal poffeffed of them, we would think it ftudded with jewels. The refemblance is the more ftriking, as thefe tubercles are of different colours. Some have the whitenefs of the diamond, others the rednefs of the ruby: fome are

yellow like a chryſolite, others blue like an amethyſt, and ſo forth.

Not leſs magnificence is diſplayed in the different colours which adorn the wings of inſects. In the firſt place, we find theſe points and ſpots of every different colours. Some of theſe laſt are round like the pupil of the eye, and like it, ſurrounded with a circle. For this reaſon, naturaliſts have given them the name of *eyes;* but, two reaſons determine me to prefer the name given them by Friſch, to wit, *mirror points*. Firſt, that they may not be confounded with the real eyes: and ſecondly, becauſe theſe ſpots are not always ſurrounded with a circular margin like eyes, but this margin is often of a different figure, and varies as much as the ſhape of a mirror may be arbitrarily varied. Sometimes there is only one of theſe on the wings of inſects, ſometimes there are many. Some have lines on their wings, either ſtraight or waved; others have broad bands; ſome have triangular marks at the extremities of the wings, or other ornaments of that kind. It would be impoſſible to deſcribe the whole of them, conſidering their vaſt variety; but in general, they are diſpoſed with as much regularity, as if they were the work of a careful painter. The upper and under ſurfaces of the wings are not always adorned with the ſame colours. It would appear, that ſome butterflies were ſenſible of this, by the manner in which they hold their wings while at reſt. They keep them ſtanding erect, as if to invite ſpectators to admire their beauty. It muſt be remarked, likewiſe with regard to thoſe inſects which have four wings, that the colours of the upper differ from thoſe of the under wings. Nor muſt I omit to mention, that theſe colours are moſt vivid in the wings of living inſects, and that they ſometimes fade when the animal dies. It is alſo to be obſerved, that inſects which

which have farinaceous wings, if they are to be kept, must not, when caught, be handled too roughly; for, as they owe their colours to that powder, or rather to those feathers, which, from their smallness, escape our senses; they lose all their brilliance, when these are either destroyed or deranged.

The membranous wings of insects have also their particular beauties. Some present to the view, an assemblage of colours like those of the rain-bow, or like those formed by the rays of the sun, in passing through a prism. They vary according to the different refraction of the rays, so that, what at first appeared red, becomes afterwards blue or green, nearly like the colours on a pigeon's neck, which change according to their different position with regard to the Sun. There are often between the nerves of the wings of some insects, small spots which appear like so many ornaments wrought on fine gauze.

We have said that there are insects whose wings are covered with a kind of case to protect them from accidents. These cases have likewise their particular beauties. In some insects they are of a uniform colour, as yellow, red of various shades, green, blue, violet, brown and black. In some these colours are dull, in others bright and shining like a transparent varnish. Of this last kind are those insects of the Buprestis and Curculio kind, whose elytra seem adorned with emeralds and gold. The elytra of other insects are variegated with different colours. Those of the Silpha Vespillo are painted alternately with transverse and waved bands of black and reddish yellow. The ground colour of those of the Coccinella conglobata is yellow, but it is adorned with square black spots like those on a chess-board. The Silpha 4-punctata has two square spots on each elytron. The Leptura arcuata is of a deep black colour

lour with yellow spots on the upper, and hook-shaped bands of the same colour on the under part. The Leptura scalaris has on its elytra indented ornaments which at the place where the elytra meet pretty much resemble Spanish point. I once found a beetle, on a woodbine growing out of a rock, whose elytra were marked with small bars, some green, some deep red, like polished copper, and others of a deep blue, like burnished steel.

The beauty of different flowers, the diversity remarkable in the colours of shells, the splendor of those in the tail of a peacock, no doubt, excite our admiration; but that they are not the only coloured bodies capable of producing that effect on our minds, we have only to cast our eyes on some insects to be convinced. Though these small animals were of no use in the world we would still be indebted to the Creator, for having given them existence. The mere sight of them gives us pleasure; the mind feels a sensible gratification, in contemplating so many beauties in so small a space. This is not all. If we are wise, we shall rise from those beautiful objects to their Maker. What must be the riches of a Being, who hath lavished so many treasures on the vilest of insects! The beauty of these creatures, which calls forth our admiration and delight, being so much inferior to that of the Creator, would it not be blindness, not to acknowledge, to admire, and to love him, who is the source of whatever is amiable and and worthy of admiration in the works of his hands? If we would proportion the degree of our affections to the excellence of their object, we ought to love God, with our whole heart. What folly is it, not to pride ourselves on the beauty of the stuffs with which we are clothed! Velvet and silk, which are the most precious of these, whence come they? They are the excrement of a vile insect. And our richest garb, is

is it equal in beauty to that with which many of these small animals are decked? With justice, we may say, that Solomon in all his glory, was not arrayed like one of these.

BOOK II.

PART II.

CHAP. I.

OF THE USES OF INSECTS WITH RESPECT TO MAN.

INSECTS, considered in a superficial manner, without entring into a particular examination of their qualities, appear to be creatures of little or no use. This is an error, which after having read this Chapter, people will not easily fall into. I confess it would be rash to decide positively concerning the particular use which the wisdom of God had in view in the creation of each individual species. We may however conclude from the use they are of, from the benefits we derive from them, that God among others, had that particular use in view when he created them. Every event in nature proclaims that whatever happens is directed by a Being infinitely wise. From this principle it follows that God hath determined the uses of animals

mals in general, and of insects in particular; and that he hath destined them to serve, some one purpose, some another. It is not chance then that hath made insects useful, but the eternal degrees of providence; and man hath only turned to his use what was originally intended for his service.

I observe in the first place that there are many insects which are used as food by the human race. It is said that there are in India people who commonly eat worms raw or prepared, and consider them as a delicacy. Some make the same use of what are called Sea-stars. Both ancient and modern history mention a species of locust, common in the eastern countries, whose flesh is as white as that of a crab; and which as it is said, has an exquisite taste. The people of these countries prepare these in a particular way. Some boil them, others dry them in the Sun before they use them. Dampier in his voyages relates, that this is practised among those people at this day. This navigator says that in some islands of the Indian ocean, there are locusts an inch and a half long of the size of ones little finger, blackish, having broad and thin wings, with long and slender legs; of these the inhabitants catch great numbers. They expose them to heat in an earthen vessel, by which means the wings and legs fall off, but the head and body become red like those of boiled lobsters and are excellent food. The same author relates that in the kingdom of Tonquin there issues annually from the earth, in the months of January and February, a sort of locusts which are there in great request as food. The inhabitants rich and poor gather as many as they can, broil them on the coals or salt them that they may keep. This food is very wholesome. In the year 1693, when an army of such insects overspread Germany, some persons tried to eat them. The celebrated J. Ludolph, who had travelled so much

much in the Eaſt, having found them the ſame ſpecies which the Orientals eſteem ſo much, made them be dreſſed in their way. He made ſome be boiled like lobſters and ſeaſoned others with pepper and vinegar. One of his ſervants having eaten of them without any harm, he ate of them himſelf, and one day regaled with the diſh the Magiſtrates of Frankfort.

Every body knows the delicious and uſeful ſubſtance furniſhed by bees. They collect it from various things. The dew which falls on flowers affords them honey; the flowers themſelves are the principal ſource from which they draw it. We ſee them hovering to obtain it above all ſorts of flowers, in gardens, meadows, orchards, woods, &c. They even extract this juice from bitter plants, ſuch as thyme, and from roſes, whence ſpiders ſuck poiſon. It is pleaſant in a fine day to ſee this humming cloud of Bees come forth to repair to the fields. There they go from flower to flower, ſucking from the nectaria, the dew of the morning, taſting every herb, bending down the leaves and extracting the ſweets. One part ſerves them for food, and the remainder is digeſted into a ſmall receptacle deſtined for that purpoſe. Upon their return their firſt care is to empty the receptacle and to lodge its contents in their combs.

There are two ſorts of bees, the wild and the domeſtic. The former require no care. They fly freely every where, and depoſit their honey ſometimes in the cavity of a rock, ſometimes in the hollow of a tree, or in places of that nature. For this reaſon the produce of their hives has been called wild honey. The latter are domeſticated, and kept in hives where they remain.

The beſt honey of Europe is, in France, that of Provence and Languedoc, particularly in the environs

rons of Narbonne: and in Switzerland, that of Appenzel. There are three sorts of honey: 1. that which drops of itself from the combs; 2. that which is pressed from them; and 3. what is boiled and afterwards pressed. The antients made great use of honey for culinary purposes, and at table. The ease with which sugar is now a-days procured, makes honey of less general use than it was formerly. It is still however an object of importance in economy.

It is with honey that the Russians make the drink known by the name of Hydromel. The operation is performed in this manner. A certain quantity of good white honey is taken, and eight times as much well-water. The water is gently heated in a vessel of tinned copper, and then the honey is put in, and the mixture is allowed to boil. It must be carefully scummed and boiled into one third of the quantity. The great art consists in its being boiled neither too much nor too little. It is known to be enough when a fresh egg will swim in it. It must moreover be observed that Hydromel ought to be more or less boiled, according to the quality of the honey employed. The best need not remain so long on the fire as the worst kind. While it is still warm it is passed through a searce to purify it, and then it is put into a cask in which there has formerly been wine. This cask is afterwards exposed for five or six weeks to the Sun, or behind a furnace, or on a baker's oven, that the hydromel may be well fermented. When all these precautions are taken it is put into the cellar. In places where there is plenty of honey, a liquor of an inferior quality is made with water, which has been used to wash the wax, and vessels where honey has been kept. It is given to servants. The peasants sometimes mix good new wine with excellent honey which affords them

a

a beverage much to their taſte. Formerly another kind of drink was made, compoſed of verjuice and honey.

Some inſects furniſh us with ſtuffs for our raiment. It is well known that the ſilk worm draws from its own body long and tough threads in which it wraps itſelf up. After having for a time been as it were buried here, it leaves its ſepulchre for the uſe of man, who uſes the materials to clothe and adorn himſelf. This inſect and its web have been known in the earlieſt times, among the Seres a people who inhabited the country now poſſeſſed by the Chineſe, the Siameſe, and Tartars. Even at this day there are to be found in China, in the province of Canton, ſilk-worms in a wild ſtate, which without any care being taken of them, make in the woods a kind of ſilk which the inhabitants afterwards gather from the trees. It is grey without luſtre, and is uſed to make a very thick and ſtrong cloth named there Kien-Tcheon. It may be waſhed like linen cloth, and it does not ſtain. Silk however was exceedingly rare in Europe for a long time. Many circumſtances contributed to this at firſt. The proper inſtruments were wanting for ſpinning and weaving it, and there was no intercourſe with the people of the countries where it grew. Can we then be ſurpriſed if ſilk was rare and dear? It is ſaid that in the days of Solomon, a woman of the iſle of Co, named Pamphila, was ſkilled in weaving and making cloth of ſilk which came from the country of the Seres. It is probable that this woman had not received from that country the animal, but only its thread. Had it been otherwiſe, how could ſilk ſtuffs in the time of the Romans have been ſo dear, and how could that high price continue till the reign of the Emperor Juſtinian? In his time two monks brought from the Indies to Conſtantinople ſome eggs of the ſilk worm. From that place they were carried into Italy, and after-

wards into Spain, and other European countries. The silk however that was gathered in Europe was not in such quantity as to supersede the importation of that from Persia. Besides much time would necessarily be wanting to bring the manufacture of it to a proper degree of perfection. The stuffs fabricated were of two kinds; the first were wholly silk: these were so precious and dear, that the Emperors alone were in possession of them. Now-a-days things have totally changed, and they are become so common that every body has them. The second sort consisted of two different threads, the warp was silk, the woof of some other substance. Polydor Virgil gives this the name of satin of Bruges.

Some inventive geniuses have endeavoured to draw from the threads of spiders, a substance similar to those of the silk worm. This was attempted by Mr Bon, first President at Montpellier. He carried the attempt so far, as to make a suit which he presented to Louis XIV. The thing well deserves to be throughly investigated. If it could succeed, clothes might be made which would prevent the money usually exported in the purchase of silk.

What I have just said shews that insects contribute to wealth and to the advancement of commerce. The merchandize of silk-stuffs occasioned for a long time the export of vast sums from France, Germany, and other countries, to Italy and the Levant. Things began to wear a different face in France in 1494 under the reign of Charles VIII. The French imported white mulberies from Naples, planted many, fed silk worms, and made silk. Henry IV. encouraged these manufactures, and Louis XIV. brought them to the highest degree of perfection, in consequence of several grants. The Germans were the last to think of the vast profits which might accrue from

from that traffic. It is true, that about the year 1599, Andreas Libarius. a learned Physician and Philosopher, made various experiments on the subject, at Rothenburg on the Tauber. But his efforts were attended with but little success till several Princes and men of rank interfered in the business. John Philip, Elector of Mentz, was the first, if I am not mistaken, who laid the affair to heart. This Prince caused many mulberries to be planted, and silk worms to be reared at Hockheim and at Wurtzburg in Franconia. He gave annual premiums to the children of such peasants as had collected the greatest quantities of silk. Frederick, Duke of Wurtemberg Neustadt made a similar establishment at his residence. Prince Charles of Lichtenstein imitated his example: He planted mulberries at Feldsberg, where so many silk worms were reared as yielded a considerable yearly profit. Daniel Kraft, an inquisitive and diligent man, made himself famous for his success in managing those insects; and it is to him that the city of Dresden owes its silk manufacture. But no person in Germany was so earnest in the business as the Court of Berlin. Frederick I. planted many mulberry trees at Potsdam, Kopenick, Spandau, and other places, where great quantities of silk worms were reared and a manufacture established, the direction of which was at first entrusted to certain individuals, but afterwards to the Academy of Sciences at Berlin. Frederick William followed the footsteps of his father with an ardour and zeal truly laudable. For this purpose he ordered large plantations of mulberries, and encouraged his subjects by rewards to make them. He likewise established a manufacture of ribbands at Charlottenburg, for the maintenance of which certain merchants advanced considerable sums.

The inhabitants of China likewise trade in silks;

of theirs, they even make paper, but it is so fine and thin, that it bears the ink only on one side.

The traffic in bees and in the wax and honey which they make is very considerable. It is well known that bees are sold in hives. If no accident happens to them, they multiply so fast that each hive generally produces two swarms a year. These are two colonies sent forth to people two new hives. Suppose a man should purchase these two swarms at two florins for the first, and one florin for the second, the following year, if things succeeded well, each hive would give him two swarms which might be sold for double of what he originally gave, while he still preserved the first two hives. If one should calculate how many swarms would be produced from the two original hives in a few years, one would see what profit may arise from these little animals. I pass over in silence the honey and wax which the hives would afford at the same time, though likewise very profitable.

In the countries where locusts are eaten, they are carried regularly to market, and sold as birds are with us.

There are insects likewise which furnish the most beautiful colours. Such is the Cochineal (*Coccus Cacti*) which Dyers use for dying red. The Cochineal is a small worm which Mr Edward Tyson thinks is a species of Scarabæus. It is of the size of a lentil, and something like a bug in shape. Internally it is of a scarlet red colour; it passes though its transformations very slowly. It abounds in New Spain, where it is found on every tree. The Indians gather them and put them under a sort of fig of that country, the fruit of which is full of a red coloured juice. This plant is called *Kumbcha*, or *Tuna*, and in Latin is known under the name of the O-

puntia

puntia spinosa fructu sanguineo, (*Cactus Opuntia.*) These worms suck the fine red fruit of this tree, and acquire its colour. When these insects have attained their natural size, the Indians make a smoke to windward of the tree, and spread a linen cloth below it covered with quick-lime. When the animals are stupified with smoke, the tree is shaken to make them fall on the quick lime which instantly kills them. They are then dried in the Sun and kept for sale.

There is found both in Poland and Germany an insect (*Coccus Polonicus*) which yields a very fine carmine colour. This insect attaches itself to the plant called in Latin, Polygonum minus cocciferum, (*Scleranthus perennis.*) There hang from its roots little vesicles, red internally, called by the vulgar St John's blood. When the root and vesicles of this plant are exposed to the Sun, there come out little flies which may be considered as belonging to the genus of ichneumon. They have white wings, and at the hinder part they have two beards of the same colour closely joined together. All the rest of the body of the insect resembles carmine, and accordingly it is from this animal we procure it.

It is to an insect likewise that we are indebted for the finest crimson colour. This little animal (*Coccus ilicis*) is found in small round vesicles, of the size of a pea, which grow on the leaves of the Ilex aculeata cocci glandifera (*Quercus Ilex.*) It is a species of very hard oak, which the celebrated Mr Rohr calls the scarlet oak. The vesicles are gathered before they open, and to prevent the little flies from getting away, these vesicles are sprinkled with vinegar. These trees are found chiefly in Spain; bnt they are said to grow likewise in England and in different parts of Germany; as in the

the Province of Bareith in Silesia and in the forests of Saxony. It would be worth while to investigate the matter, and to examine at the same time the season in which these vessels are filled with flies. A greater number of these trees might then be cultivated, the insects gathered, and we might find at home, at little expence, what we send so far, and pay so high to obtain. The peasant and his master would then be equally benefited, the one by selling the insects he had gathered, the other by the tax which might be laid on the traffic.

Besides the two kinds of plants, on which these insects are found, diligent Naturalists have discovered others, with red vessels at their roots: Undoubtedly these would likewise produce a red colour, like the others. It needs only to be tried by experiment, whether their cultivation would be worth the while.

I add, in order to finish this article, that there is a sort of Bees in the Indies, considered by some as winged ants, which are likewise of great use in dying. They make a sort of wax, called *gum lac*, which is used in dying red.

The wax made by bees has several uses, which ought not to be passed over in silence. The antients wrote upon it. They made little plates of wood, like the leaves of our pocket-books, with a raised border all round, to prevent the wax from running off. Melted wax was then spread on these plates, and made smooth, so that they wrote upon it with a point, nearly in the same manner as our engravers write on copper. A few years ago I saw an antiquity of this kind, in the town-house of Arnstad. These tablets are no longer in use, both because what was written could be easily effaced and because paper is so much more fit for the purpose. I shall say

nothing

nothing of the ufe formerly made of wax, in defending dead bodies from putrefaction, but confine myfelf to the ufes it ferves in the prefent times. It is mixed with pitch, in order to ftop up chinks and crevices, through which water gets into cafks. It is likewife ufed to prevent air and rain from getting into the wounds of trees, whether made for engrafting, or accidentally. It was formerly ufed in fealing letters, and other things of that nature, and various colours were given to it. Now a-days, when we are acquainted with a better fort of wax, common people no longer ufe it; but magiftrates and perfons in power ftill imprefs their feals upon it, and attach them to public inftruments and papers of importance. Wax was likewife antiently ufed in painting; any colour was given it at pleafure; portraits were made of it, which were afterwards hardened by means of fire, many works in relief were likewife fabricated of wax, and even the whole human figure has been formed of it. But as that was expenfive, it was only perfons of diftinction who could procure them. Among the Romans, it was thofe perfons only who had exercifed the curule offices who had *the Right of Statues*. Thefe the Poets call ceræ, becaufe they were of wax. In the year 1714, I faw at Berlin, a magnificent fpecimen of this in the king's cabinet. It was the portrait of his majefty, Frederic king of Pruffia. The workmanfhip was fo exquifite, and the features fo ftriking, that at firft fight one could not help faying, "there is the king." The great likewife ufe candles made of wax.

It is well known, that there are feveral animals which, like living barometers, predict changes of the feafons. Infects have the fame faculty. At the approach of winter they conceal themfelves, and when the grafshoppers appear, they announce to us the fummer. We may expect a ftorm or heavy rain,

when

when bees retire hastily into their hives: we have reason to dread the same, when ants conceal their eggs, when gnats bite severely, when butterflies do not rise very high in the air, and when worms come out from their holes.

Insects purify the air from noxious vapours and exhalations. They are like natural spunges, which attract them, as has been remarked in dried toads. Mankind have used them as a means of defence on certain occasions. I recollect a very singular thing, which happened at Hohenstein, in 1525. In the time of the war, the peasants having collected together, went to pillage the house of Elend, a clergyman. He, having used all his eloquence to dissuade them from their design in vain, sent his servants into the garden, with orders to bring out his hives of bees, which being thrown in the midst of the assailants, put them instantly to flight. Insects are used as bait by anglers, who not only fix earth-worms on their hook, but various flies, and the larvæ of the Ephemera. Eels are observed to be remarkably fond of this last insect. The Lacedemonians used small pieces of wood, eaten by insects, to impress their signatures on wax.

CHAP. II.

Of the use of Insects in theology.

If we consider with attention and without prejudice what has been already said, we shall be obliged to acknowledge

knowledge that these minute animals raise our ideas to the knowledge of the Creator of the universe. Had they no other use but that of enabling us to go back to the first cause, would not we have reason to conclude that those insects which we consider as noxious are of infinite use to the man who is willing to contemplate the works of God?

In order to manifest his dominion over insects God ordained that the first fruits of honey should be presented to him. He did not desire it as an offering by fire, but he required it to be placed on the altar, as an oblation of first fruits for a sweet savour. LEV. ii. 11. 12. We find also that the Hebrews acquitted themselves of this duty, and that they offered the first fruits of honey. "The Children of Israel," (says the author of the second Book of Chronicles,) "brought in abundance, the first fruits of corn, wine and oil, and honey, and of all the increase of the field."

Insects are a scourge in the hand of God to chastise the wicked. "The vengeance of the wicked, says the son of Sirach, is fire and the worm."—ECCLES. vii. 17. Accordingly he threatens those who refuse to obey his will, to employ insects to punish them for their disobedience. Thus Moses expresses himself on the same subject. "Thou shalt carry much seed out into the field, and shalt gather but little in, for the locust shall consume it. Thou shalt plant vineyards and dress them, but shalt neither drink of the wine, nor gather the grapes; for the worms shall eat them." DEUTR. xxiii, 38, 39.

Experience has often justified the accomplishment of this threat. There is no creature how despicable soever it may be, of which God cannot form armies superior to all the force of man, and capable

 of

of chastising the wicked in a dreadful manner. Men can oppose and resist armies of men; but they cannot face an army of insects. In vain would they employ against such an host their most formidable weapons; neither fire nor the sword could avail. The vilest insects have been known to take possession of a country, and to banish the inhabitants.

CHAP. III.

OF THE USE OF INSECTS IN JURISPUDENCE.

As a good or a bad use may be made of insects; Magistrates have been obliged to make laws to regulate their possession. Lawyers, considering the advantages obtained by Bees, have made certain regulations to secure the possession of them to the proprietors. Although they fly hither and thither to procure their food, the property in them, remains to the possessor of the hive. When they swarm they belong to him as long as he can follow them, and prove that they are his. This is the decision of the Roman Law. That of the Saxon code is quite different. The proprietor loses the possession of them as soon as they are out of the hive. Some lawyers pretend however that the law permits the proprietor to follow the swarm and to take it on the possession of his neighbour: but if he neglect

neglect to pursue it, it becomes the property of him who seizes it. Whoever steals a hive is punished with death.

Lawyers have also examined this question, whether a tenant who in his contract has renounced in general terms all accidents, is obliged to support the loss caused by an army of locusts, or if the Lord of the Manor ought to sustain it? It has been decided thus. If the accident which happens, is of such a nature that it could neither be foreseen nor prevented, the Lord of the Manor must bear the loss: in every other case, the tenant must suffer it. Very rigorous laws have likewise been made against certain persons wicked enough to poison their fellow creatures with the hairy caterpillars called Pithyocampæ. Every body knows that when there is an unusual number of caterpillars, locusts or other insects of that kind, it is the duty of the Magistrate to order their destruction, and to point out the best means of accomplishing it. There have been nations that made use of insects to punish criminals. The Jews for instance, employed either ants or bees in the punishment of adulterers. They put them naked into an ant-hill, or exposed them to the stings of a swarm of bees.

CHAP. IV.

Of the use of Insects in medecine.

The use of insects in medecine is not so common as that of other animals, because Physicians have not

given themselves so much trouble in investigating the properties of the former, as they have done with regard to the latter. I flatter myself however I shall be able to shew that they are not without their use in that science.

In vegetable physiology for example, there are insects that make the skeleton of a leaf in the highest degree of perfection; they gnaw and devour the substance of it, leaving nothing but the fibres and nerves through which the nourishing juices are conveyed. This operation is so well performed, that man with all possible care and pains could hardly imitate it.

Insects are as useful in Osteology. If we wish to have the skeleton of any of the smaller animals, we have only to take off their skin, anoint them with honey, and bury them in an ant-hill, or expose them to the voracity of some other insects. They will, by degrees, eat away the flesh and entrails of those animals, and they will remove from the bones, the most minute parts of the flesh which adhere to them. But as they cannot penetrate the tendons, on account of their hardness, these will remain intire, and continue to connect the whole bones to one another. It is thus, that, by the assistance of insects, we can, without trouble, procure skeletons of all the smaller animals, made with the greatest possible neatness.

They have likewise contributed to enrich anatomy. It is by means of an Indian insect, called Nigua, (Pulex penetrans,) that anatomists have had an opportunity of discovering the error of a very general opinion. It was believed formerly, that the blood took its course from the extremities of the arteries, to enter into the veins; but this insect has taught us the contrary. It insinuates itself into the skin, where it causes

caufes violent pain, if care is not taken to have it removed. For this purpofe, the Indians pafs, with the greateft circumfpection, a fharp pointed and fine needle, through the pores of the fkin, at the place where this enemy lies hid. Then they turn it in every direction round the tumour, in the midft of which he refides, that they may detach it from the reft of the body, and get it away with the animal himfelf. When this tumour is examined with a glafs, the infect is feen inclofed in a fort of tranfparent pearl. There are likewife obferved in it, two or three fmall red points, which are the extremities of arteries. Now, if the blood paffed into the veins, by the extremities of the arteries, it would follow, that thefe red points, fo diftinctly feparated, ought to unite, or at leaft to have fome communication with them. I do not deny all communication between the veins and arteries, but that fort only, which anatomifts fuppofe to be made by anaftomofis. There is another kind, which is made by the ramifications of the arteries and veins, and this I admit.

Infects are likewife ufeful in the cure of difeafes. Experience teftifies, that they may be employed advantageoufly, not only for external wounds, but internal diforders. Phyficians dry thefe little animals in the air, or fome of their parts, reduce them to powder, and give them to their patients in a convenient vehicle, or made into the form of confection, or conferve. Some digeft them in oil, and make a balfam of them; others kill them in oil of olives, and ufe the oil. Some diftill them while recent, which extracts a water from them, and reduces the reft to afhes, from which laft is drawn, by means of the firft water, a fixed falt. Different reafons may be given for the virtues contained in thefe little animals. One, that the falt they yield, is more penetrating, and more volatile than that of others; that

they

they possess a natural oil, which produces good effects, and lastly, that they are endowed with a more efficacious sulphur.

I shall not, I think, wander from my subject, if I here mention those insects, that have hitherto been used in medicine. I begin with leeches, which, when applied externally, have the same effect with cupping glasses. The kind chosen for this operation is a small one, having its back marked with streaks, (Hirudo medicinalis.) They are not so hurtful as the others. Before employing them, they must be kept some time in pure water, to purge them. The place they are to be applied to must be previously rubbed with nitre, blood or clay. When they are to be removed, let them be sprinkled with a little salt or ashes. No external use is made of them, but for sucking the blood. In severe head-aches, they are applied to the temples; for gentle evacuations, they are fixed on the arms or feet; they are likewise applied to the hæmorrhoids, to open those that are close. Sometimes they are made use of for obstructions, in female cases.

Earth worms are said to produce excellent effects in medecine. They promote perspiration, provoke urine, allay pain, soften, resolve, and dissipate constipations, increase milk, and cure wounds. They are often used in cases of apoplexy, in contractions of the limbs, and other accidents of the nerves and muscles; in jaundice, dropsy and cholic, and particularly in rheumatism. They are employed both internally and externally. When taken internally, they are bruised while fresh, mixed with wine, and strained through a cloth. Others dry them, and reduce them to powder. For external use, they are kept either alive, or after they are dead. Applications of living worms are good against the cramp or

worms

worms, when laid on the part affected. Dead worms are taken to assuage the pain, occasioned by a carious tooth, or the gout. In the first case, the hollow of the spoilt tooth is filled with their powder; and in the last, that powder is mixed with a quantity of meal, and applied to the part affected.

Of those insects which have feet without wings, spiders are said to be of great use in medicine. The great spider, with the cross, (Aranea diadema,) has been particularly recommended in intermitting fevers. For this purpose, it is inclosed in a nut shell, tied round the neck, or applied to the pulse, which, it is said, carries off the fever. Some persons have advised as a cure for the ague, a spider's web, mixed with the white of an egg and soot, which they apply to the pulse. A spider's web is advantageously used in hæmorrhages.

The Onisci are not less useful. These insects assist digestion, are a good attenuant and aperient; with these qualities, it is not surprising that they should serve to dissolve viscidities, to open the vital organs in jaundice, gravel, retention of urine, and cholic; and to restore lost appetite, arising from foulness of the stomach. External applications are also made of them for diseases of the eyes, pain of the ears, and inflammation of the throat. The powder of them is mixed with honey, and rubbed on the diseased part. They are applied living, for the cure of that species of ulcer, called Phadagæna, which eats like a cancer.

The silk-worm also deserves a place here. After being dried, and reduced to powder, they are sprinkled on the crown of the head, to defend it against vertigos and convulsions. Their web or silk produces the same effect; for, if velvet is reduced to powder, and

and given to those troubled with the falling ſickneſs, they are relieved. The ſmoke of ſilk ſtuffs burnt, is likewiſe of ſervice to women ſubject to diſeaſes of the matrix. The powder of burnt caterpillars, taken like tobacco, ſtops bleeding at the noſe. Earwigs fortify the nerves, and are good againſt convulſions. They may be infuſed in oil, and after being left there for ſome time, they muſt be boiled, and laid upon the diſeaſed parts. The powder of this inſect, mixed with the urine of a hare, and put into the ears, is good for deafneſs.

Thoſe who have no repugnance at ſwallowing lice, will find them a ſpecific againſt the jaundice. But this remedy proved fatal in one inſtance, to a youth, in whoſe ſtomach, when he was opened, a great quantity of this loathſome inſect was found. Some uſe them in agues; ſwallowing four or five of them during the fit. It is certain, that theſe inſects ſuck the bad humours from the bodies of children. Scorpions, reduced to aſhes by fire, and taken in powder, promote the diſcharge of urine, retained by the gravel or ſtone. They furniſh likewiſe a remedy againſt their own bite. It is only neceſſary to cruſh them upon the wound, or to anoint the place with oil of almonds, in which theſe animals have been infuſed. The tick burnt to powder, and ſpread on the head, makes the hair fall off. It cures the Eryſipelas and itch. Bugs burnt and taken in powder, expell the after-birth. If the head is anointed with oil, in which the ſea polypus is boiled, the hair falls off.

Winged inſects, with membranous wings, are alſo of various uſes in medecine. The powder of dried bees makes the hair grow, if the place they have fallen from is rubbed with it. Honey, on account of its balſamic quality, is agreeable to the breaſt, to the lungs and reins. Wax, applied to wounds, cleanſes them,

them, aſſuages the pain and cures them; and this is the reaſon, why it is an ingredient in plaiſters. It ſoftens corns on the feet, ſo that they are eaſily taken out. For this end, it is mixed with turpentine, in which has been put a portion of bruiſed verdigreaſe; of this is made a plaiſter to be applied to the corn.

Crickets are uſed to fortify weak ſight, the liquid ſubſtance being expreſſed and put into the eyes. They likewiſe ſoften the glands, when the ſame ſubſtance is rubbed on them. Common flies are emollient, abſtergent, and make the hair grow, when, after being bruiſed, they are applied to the bald part. The water diſtilled from them, is good againſt diſeaſes of the eyes. When uſed, it muſt be made into a plaiſter with the yolk of an egg. Galen approves this remedy. It likewiſe makes the hair to grow, removes freckles, and reſtores hearing. One perſon, ſure that no purgative could have produced the effect, ſwallowed four or five gnats, and was effectually purged. It is likewiſe ſaid, that the red gnats, taken in infuſion, are an excellent remedy againſt the falling ſickneſs. Oil from the aphides was much eſteemed formerly. Waſps have the ſame qualities as millepieds; that is, they provoke urine, and bring away gravel. The ſpongy excreſcences, which are ſeen on wild roſes, are good againſt the gravel, but have that property, merely becauſe they ſerve as a neſt to a ſpecies of ichneumon. If, like tobacco, one ſmokes the neſt of waſps, it will appeaſe the pain of the tooth-ach.

The other kind of inſects with hard wing-caſes, are not leſs uſeful in medicine. The cochineal inſects provoke urine, like the millepieds, becauſe like them, they contain a deal of volatile ſalt. The powder of this inſect, mixed with ſugar, is alſo uſeful againſt the cholic, the ſtone, and the meaſles. Flying

ſtags are uſed againſt pain and tenſion of the nerves, and againſt the ague. Reduced to powder, they aſſiſt delivery. Infuſed in oil, they relieve pain in the ears. The powder of the dung beetle, ſpread on the viſcera, in a rupture, makes them go back. This inſect, boiled in lintſeed oil, is good againſt the hæmorrhoids, and pains in the ear. Cotton is dipped in this oil, and applied warm to the part. Cockchafers are nearly of the ſame nature with cantharides. Taken in powder, they promote the ſecretion of urine and blood, cure the bite of a mad dog, and relieve the rheumatiſm. Some perſons apply, externally, the juice of this inſect to wounds. It is likewiſe put into plaiſters, to be uſed againſt carbuncles and tumours. By infuſing this animal alive in common oil, the liquor ſerves the ſame purpoſe with oil of ſcorpions.

Cantharides are rarely taken internally, but great uſe is made of them in external applications, in the form of bliſters. They are ſerviceable in head-achs and megrim; in diſeaſes of the eyes, and in blindneſs, occaſioned by mercury, or other remedies, that repell the humours; in ſinging of the ears, they are applied as bliſters behind the ear: in deafneſs, cauſed by external violence, in the falling ſickneſs, in tooth-ach. Cantharides are alſo a good remedy in the ſciatica, when applied to the calf of the leg; in intermittent, as well as in malignant fevers, but they are a remedy to be uſed with the greateſt caution. The ſmoke of locuſts is good in retention of urine, particularly in women. Some hang them round the neck in agues. They provoke urine, diſſolve the ſtone, when eaten, or when taken in powder.

Ants likewiſe are much in uſe. They are warm, dry, and aphrodiſiac, and their acid ſmell wonderfully enlivens the vital ſpirits. The large ants are a remedy

medy against the tænia, the itch, and the leprosy. To use them, they must be dissolved with a little salt, and the diseased part anointed with the liquor. The spirit of ants is an excellent remedy against diseases of the ear, such as deafness or ringing. Cotton dipt in this spirit is put in the ears. It sits also easy on the stomach. It fortifies all the senses and the memory. It re-animates the strength, and gives vigour. It is preferable to all sorts of apoplectic and strengthening waters, particularly in the cure of catarrhs It is externally of great use in sprains, in apoplexy and in atrophy, caused by a wound. It is mixed with waters agreeable to the nerves, or with arthritic spirits. The eggs of ants are efficacious in deafness. If the cheeks of children are rubbed with them, the down falls off. The quantity of wind they excite, when a single dram of them is taken, is very remarkable. If an ant nest is boiled in water, and one washes in it, it dries, warms, and fortifies the nerves. Accordingly, it is used in the gout, palsy, diseases of the matrix, and cachexy. In the nests of ants are found small bits of matter, having the smell of amber or incense. These are formed by the insects from the resin of pines. In Norway and in Germany, they are used in perfumery.

CHAP. V.

OF THE USE OF INSECTS WITH RESPECT TO OTHER ANIMALS.

I HAVE sufficiently proved, in the last chapter, that insects are useful to man. I shall now shew, that

they are no less beneficial to the other animals. They serve them for food and physic: one insect even is used as food by others. Mr de Reaumur found, that some caterpillars devoured one another. But, as he observes, that they do not come to this extremity, till their proper food is withered, it is probable that these insects are driven to it by necessity. Perhaps those insects were of a species that require a deal of fluid for their subsistance. The minute pulices aquatici, which discolour the surface of waters, serve for food to the aquatic insects, which change into gnats. A most admirable ordination of Providence! Small as they are, the Author of Nature has created animals, small enough to be swallowed whole by them. Of insects that live on land, spiders devour flies, wasps destroy bees, and grasshoppers ants. Serpents often make an excellent repast of caterpillars, chafers, &c. There is a species of snail, which devours the entrails of certain insects.

The avidity which fishes discover for certain species of insects, does not permit us to doubt, that they are to them a desirable food. The monstrous whale feeds on small sea insects. How astonishing is it that such food can satisfy an animal of such enormous size! In rivers, gnats are almost the only food of the shad-fish; and the pulices aquatici are the favourite food of the tench.

Insects it is well known are the most common food of a great number of birds which feed their young with them. This is therefore the reason why the greater part breed only in the spring, when there is plenty of caterpillars on the hedges and trees. Even those of them which when old eat grain or seeds, nevertheless nourish their young with insects, birds are naturally warm, therefore they must always have something to digest. We cannot here cease to ad-

mire the wiſdom of the Creator who, that birds may not want nouriſhment, has created ſuch a prodigious multitude of inſects. This wiſdom is particularly remarkable in this, that ants are of all inſects the moſt numerous, becauſe no ſpecies is ſo much preyed upon by birds. Inſects therefore may be ſaid to be a ſort of game after which birds are perpetually in chace. The wagtail and blackbird eat worms. Crows and ſtarlings light upon ſheep newly ſhorn, to feed on a ſort of blue lice which are then viſible at ſome diſtance on their ſkin. Ducks diving under water, devour the pulices aquatici. The little tit-mouſe and red-throat very dextrously catch flies on the wing, and thin the air of them. The woodcock and the ſnipe ſeek for ſmall worms in the marſhes. The large tom-tit will kill from ten to twelve bees, and tearing out the entrails and honey bag, convey them to its young. The eggs of the ant are the food of the young nightingales. Swallows live entirely on bees, and other inſects which they carry to their brood. Woodpeckers ſeize with their tongues, the inſects which live in holes of trees and in clefts in the bark. This nouriſhment fattens many ſpecies of birds. It is at leaſt certain that poultry lay oftener, when they have an opportunity of feeding on beetles and earth worms.

I muſt here remark the wiſdom and goodneſs of the Creator. While he has given to birds a deſire for certain inſects he has alſo beſtowed on them the neceſſary members and qualities for ſeizing them. Snipes, herons, and other water birds which are obliged to ſeek for inſects under water, have their bills long enough for this purpoſe. Ducks which are obliged for the ſame purpoſe to remove the mud have their bills broad. The wood-peckers which penetrate tke bark of trees, have their bill hard, ſharp, and fit for boring. The upper part of it is the moſt raiſed,

raised, and seems to be applied to the under to give more strength to the whole bill as well as to serve for ornament. When we view it, we cannot help admiring the art with which it is laboured. Besides this advantage, this bird has the tongue slender like an awl, and uses it very adroitly in catching the insects: the point of the tongue therefore is endowed with a certain hardness, and on both sides it is furnished with small curved hooks which prevent the insects from disengaging themselves when the bird draws its tongue into its mouth.

Insects likewise serve as food for quadrupeds. In the Indies is found an animal which hunts for insects, and devours them with avidity. The young armadillos feed on a species of locust which, because they have on their neck a sort of hood, have been called *Monks*. Bears are fond of ants and honey, and they go in search with great eagerness of the nests of wild bees. The Chameleon, and some other species of lizards eat flies. The principal food of the badger is the dung beetle, worms, and other insects of that kind. If we may believe Ælian, foxes are not only greedy of poultry, but also fond of honey, and for this purpose seek the nests of wasps. Frogs lie in wait to seize upon bees when they come to drink. Dogs dig up the Cicadas and eat them. The mole which lives in the earth, feeds on worms and millepieds.

The members of those quadrupeds that feed on insects, are provided with the necessary qualities for seizing their prey. The tongue of that animal of the Indies, which lives on ants, is long and limber. He thrusts it out, far from his mouth, and darts it into an ant hill, whence, after the ants have got upon it, he withdraws it again into his mouth. The tongue of the chameleon is likewise long, pointed, and

and covered with a viſcid liquor. This animal keeps his mouth open, and when flies, ants, little beetles, or other inſects paſs within his reach, he darts out his tongue, with the ſwiftneſs of an arrow, and when he has once catched them, they cannot eſcape: they are ſtuck on the tip of his tongue, as they would be on the point of a pin, or they are retained by the gluey ſubſtance which adheres to it, as birds are with bird-lime.

Inſects, which ſerve for food to certain animals, afford medecine to others. Poultry, when diſeaſed, ſwallow ſpiders, which purge and cure them. Bears, when troubled with indigeſtion, dip their tongue in honey, (as Plutarch relates,) and thruſt it into an ant-hill: when the ants have gathered on it, they draw it in, ſwallow the ants and are cured. To avoid prolixity, I ſhall not adduce any more inſtances.

After mature reflection on what has juſt been ſaid, concerning the uſes of inſects, we cannot ſurely heſitate in concluding, that the Being who formed them, is all-wiſe and almighty. His power appears, in his having conjoined ſo many qualities in ſuch diminutive animals: and his wiſdom, in having rendered them equally uſeful to men and brutes, in health, and in ſickneſs. It is our duty to attend ſeriouſly to theſe circumſtances; to have our hearts penetrated with gratitude to our Creator, and to offer him our continual thanks.

Man, endowed with reaſon, convinced of the utility of many inſects, cannot help acknowledging, that there are many ſtill, whoſe uſes are totally unknown. In this perſuaſion, what can he do better, than apply himſelf to the aſſiduous inveſtigation of their properties? The objection that many are noxious, is not a good one. I ſhall anſwer it in the

succeeding chapter. The inutility of many others, is by no means better; it is abfolutely falfe. For it muft be obferved, in the firft place, that we cannot fay a thing is ufelefs, becaufe we are unaquainted with its properties: Experience teaches us, that, by careful examination of fome things, which, for a long time, had been regarded as ufelefs, they have been found poffeffed of very valuable properties.—Befides, we muft diftinguifh between utility mediate, and utility immediate. All things are created for the glory of God, and the ufe of man, although man does not enjoy the whole immediately. It is but a fmall part of the infect creation which ferves as food for man, but how many fpecies are devoured by birds, by fifhes, and other animals, which afterwards afford him fubftantial aliment. Hence it follows, that infects, ufeful to other animals, are ufeful to man. But further, many infects, as I have already fhewn, are of immediate utility to man. And is there not a fufficient number to prompt him to examine, whether there are not others, that may be equally ferviceable to him?

They may be collected in different ways. It is eafy to take in the day time, thofe which eat only during the night, becaufe, then they remain at reft, among the leaves. On the other hand, thofe that fly only by day, are eafily taken during the night. A lighted candle in a lanthorn, attracts them, and brings them within our reach. In rainy weather too, they take fhelter under the leaves, or in other places where they are found without difficulty.

As caterpillars feed themfelves, it is not difficult to rear them when they are taken. However, there are feveral things worthy of obfervation on this head. Whenever I took any, to obferve their tranfformations, and to ftudy their nature, I put them in-

to

to pretty large glass vessels, as wide at top as at bottom. Before putting them into this vessel, I took care to fill it half full of earth. I afterwards covered it, leaving, however, free access to the air, and put it in a place, where it was not exposed to the rays of the sun. I gave fresh food, every day, to such caterpillars, as I knew lived upon particular plants; but to such whose kind of food I was ignorant of, I gave at first, such leaves or other things as I had found them on. If they did not touch these, the next day I gave them other leaves, and I continued thus, till I discovered the food that suited them. As great profit is derived from bees, it is of great importance for those who have opportunity, to know how to cultivate them. But as this subject is too copious to be fully treated here, I shall confine myself to the principal circumstances.

Bees require great care and attention. In the first place, their hives must be judiciously placed. They should be situated in an air neither near a swamp nor moist. It is of advantage, to have in the neighbourhood, little rivulets of running water, not surrounded with tall trees, nor having on their banks, too luxuriant herbage. There should likewise be in the vicinity of the hives, abundance of all sorts of odoriferous flowers. The hives must be very clean; and free from all impurities, such as spiders webs, mouldiness, moths, clefts, &c. During winter, they ought to be laid over with plaister, that the bees may be kept warm, and that no insect may penetrate to them. When the honey is taken in autumn, care must be had, to leave enough to serve them for food during winter. In the months of May, June, and July, they must be watched, that the swarms may not be lost. The hives which are strong swarm in May, those less so before St. John's Day, and the weakest after that time. If it is wished to have the swarm remain in the hive destined for it, certain pre-

cautions must be used, and it must be introduced with address. The diseases of bees are a sort of plague, and a diarrhœa. The first is occasioned by moisture falling on the hives in autumn, which communicates with the honey, renders it mouldy, and infects the bees. If it be discovered in time, it may be remedied, by cleaning the hives, and exposing them often to the air. The second arises, when they over-heat themselves in the spring, or light upon noxious flowers. It is remedied, by introducing some honeycomb into the hive by its aperture at top; or by mixing a certain powder with honey, and giving it to the bees. The enemies of bees are the stork, swallows, pigeons, jays, wood-peckers, mice, snakes and ants. Some species of these last eat the bees themselves, others the honey, such as drones, wasps and hornets. Amongst the things that are disagreeable to them, we must reckon savin, boxwood, wormwood, salt, putrid water, all sorts of strong and bad smells, or exhalations, smoke, thunder, lightning and great noises.

As to silk worms, the following is the method of treating them. To enable them to construct their cone with the greater facility, they are put into a paper, rolled up, so as to be pointed at one end, and wide at the other. This method is proper, only when a small number is to be reared. But if a considerable quantity is maintained, it will be better to put them upon branches of the white mulberry, which will procure them the advantage of living in a cleanly manner, without being surrounded by their excrement. There is another regulation to be observed with such as are just hatched. They are fed with leaves of lettuce, but with all the economy which the delicacy of their state requires, that too great a quantity of this food may not prove fatal to them. Supposing their life divided into three stages, the

the following rule is to be observed: One portion of lettuce daily is given to the youngest; the double to those in the second stage; but, when they have arrived at their natural size or third stage, they will need more than triple of what they got at first, that is to say, five parts must be given them.

These insects eat indifferently fig and young elm leaves, but those of the white mulberry are their most favourite food. When these are given them, care must be taken, that they be neither moist, nor too succulent. The leaves of the young mulberries, or of those that grow in a moist soil, have this defect. Such an aliment does not suit their constitution. On the contrary, it is very hurtful to them, and almost always fatal. The best food for them is, the leaf of those white mulberries that grow in stony and dry places, on hills and mountains, which are open to the free air, beaten by the winds, and exposed to the violence of tempests. Such a tree has its juices purified, and fit for the nourishment of silk-worms. Should the leaves happen to be surcharged with dew or rain, the situation of the tree soon shakes off the humidity, and the wind restores its former dryness.

I would not, however, advise any one to trust in this case, entirely to chance. I would rather chuse to delay gathering the leaves till the sun has succeeded the rain, or till mid-day, before making a provision of leaves, nor would I feed my silk-worms, before I had wiped off all the humidity which has escaped the winds, or the heat of the sun.

I cannot sufficiently recommend the keeping of the place where they are reared, neat and clean.—Great care must be taken in the cleaning, which is done with a delicate rush or with a feather, not to

come too near these delicate bodies, which can hardly be touched without hurting them. All places are not equally fit for them; they should neither be too dry, nor too moist, nor subject to be infested by such insects as they have an antipathy at, or which are restless and turbulent. Of all exposures the least favourable are those of the north and south. The winds from these two quarters are exceedingly pernicious to them, the one by its coldness, the other by its humidity; for which reason, it is necessary, that the place be so disposed, as that its temperature may be regulated, by shutting the windows on one side, and keeping them open on the other, according as the wind shall blow from the north or south. When the weather is moist, it is proper to keep the place quite close; but when it lightens, that is not sufficient; the silk worms must be covered up, otherwise they contract a disease, which some curious persons have thought proper to term jaundice. They do indeed acquire a yellow colour, lose their appetite, and die insensibly. Those that die, should be separated from the living, for fear of communicating infection to them.

BOOK II.

BOOK II.

PART III.

CHAP. I.

HOW INSECTS HURT THE PRODUCE OF THE EARTH.

NOT only do insects pillage and ravage the fields, but they attack man in his domestic economy, and do him infinite mischief. Nothing can be protected against their ordure; we see, with regret, our most precious furniture tarnished and infected by flies. These restless insects enter our libraries, nestle in our cabinets, pass from one apartment to another, and leave every where behind them, the most conspicuous marks of their having been present. There is not a man, from the king to the poorest of his subjects, who can defend himself against their attacks.

Husbandmen perhaps are the most to be pitied. How often do they not find themselves disappointed of a plentiful crop by the depredations of locusts! These voracious animals often leave distant countries, traverse oceans, pour in myriads upon sown fields, and deprive them in a few hours of every appearance of

of verdure. Are not caterpillars often as noxious to us? I know not a more cruel ſcourge for gardens than they are. They eat into flowers, they gnaw the roots, and ſo deſtroy the plants they touch, that we are obliged to throw them away. Some do not wait till a plant is able to furniſh them food for weeks, they devour it the moment it appears. Others on the contrary wait till the ſeed is produced; they then devour it ſo greedily, that nothing is left but the empty ſkin to the owner. Weevils are not behind hand with theſe; they pierce the ripe grain, eat the pulp, and thus rob our granaries of that food which is of the greateſt importance to the human race.

But it is not on herbaceous plants alone, that inſects bring ruin; their attacks are not leſs diſaſtrous to fruit trees. If they depoſit their eggs in autumn, the young caterpillars are hatched in the Spring when the trees are only beginning to ſhoot forth, and they commit ſuch ravages on the buds and foliage, that wherever they are found in numbers, the fruits of the year entirely fail. The ſmall Curculios, ſome beetles and ſeveral ſorts of caterpillars conſpire in producing this devaſtation, and ſometimes reduce the trees to the ſame ſtate they were in during winter. This is not all, for there are ſome ſorts of golden coloured beetles which produce two ſorts of larvæ, red and white. Theſe larvæ penetrate the bark, and ſuck the juice till the tree becomes completely dried up. There are alſo ſome ſmall beetles which, not content with eating the bark, attack the wood, and contrive to deſolate whole foreſts. This accident has but too often happened with woods planted with pines. The wood of Schwartzenburg experienced this to ſuch a degree in the year 1736, as coſt its proprietor many thouſand crowns. I ſhall content myſelf with this one example; thoſe which I could adduce of many other ſorts which

which destroy wood are too common not to be known by every one.

CHAP. II.

OF THE EVILS WHICH INSECTS CAUSE TO MAN.

WE have spoken of the ravages which insects make both in the country and in towns; let us now take a view of the mischiefs they occasion to man himself personally. Some disturb his sleep, others oblige him to pass whole nights without sleeping at all. Indeed, what does he not sometimes suffer from the restless flea, and the loathsome bug? How can he take rest when unhappy enough to be exposed to the sanguinary insults of such tormentors? But were he free from these, the gnats do not cease to persecute him. Their incessant buzzing disquiets him, and whether asleep or awake, while in darkness he is equally a prey to those stings which he dreads but which he cannot prevent. In the East Indies the inhabitants are exceedingly tormented by those insects which the Portuguese call Mosquitoes. These dangerous animals dart upon those whom they surprize asleep, and in such prodigious numbers that it is no easy matter to resist them. When one is stung in the face, or in any other part of the body, there ensues a considerable tumour, accompanied with itching and intolerable pain.

There

There is another kind of insects which are hurtful to man by mere touch. Such is the Scolopendra marina, which causes a pricking in the skin, and a heat similar to that which one feels after having touched the common nettle. Among those which render themselves formidable by their prickles, some have the hair so acute that they wound almost imperceptibly, occasioning an inflammation which quickly brings on fever; others, as the hornet and bee, strike with their sting, and though the wounded part does not bleed, it does not suffer the less, and a sensible swelling succeeds. Besides these different insects there are others which like the gad fly have stings so sharp and strong that they can pierce the skin through gloves and stockings; others are remarkable by their bite like spiders; and some attach themselves to our bodies and suck the blood. The East Indies swarm with leeches, to which the Dutch have given the name of Snygers. They lurk in general among the grass, when the dew has moistened the ground, and as the country, which is intersected by rivers, torrents and swamps, obliges travellers to walk for the most part with naked feet, it happens that these animals cling to the legs and gorge themselves so with blood, that they fall off spontaneously. There are some so greedy that they thrust their head into the skin as far as the neck, and the only method of making them quit their hold, is by surrounding them with moistened gun powder, when they will come away of themselves in about a quarter of an hour or thereabouts. If a person ignorant of this expedient should think of employing force to detach these animals suddenly, he would pay dearly for his imprudence. Not only would he experience violent pain, but a part would remain in the skin, engender an abscess, and corrode the flesh to a great depth. I appeal for the truth of this to the sad experience of many persons who for several years have been subject to

suppurations

suppurations similar to those formed by the cautery, from having torn away these insects inconsiderately from their legs.

Let us proceed to other insects which like moles glideunder the skin, and vex and torment us without the smallest remission. In the East Indies there is a sort of worm known by the name of Culebrilla; its head and tail are extremely slender and acute. It is nearly a yard in length, aud its body is as small as the string of a guitar. This animal gets between the skin and the flesh, and there occasions a tumour, of the size of a small bean. Although it causes neither fever nor pain, it is exceedingly troublesome. At every time it stirs the person feels something disagreeable to which it is not possible for him to accustom himself. The inhabitants of Brazil suffer much from a species of insect called Nigua, which pierces the skin, penetrates deep into the flesh, and there infallibly causes gangrene, unless by suitable remedies, applied in time, these dangerous effects are prevented. The itch is caused by insects as well as other cutaneous diseases. Lice cause a disease which in the opinion of Blancard, happens generally to persons to whom some other has communicated a great number of these insects at once. In proportion as they feed they excite an itching; the hand scratching the place where they are makes wounds which suppurate, and become so many receptacles proper for nourishing the young vermin, which penetrate further and further, and entring at one place go out at another. Their immense multiplication convinces me that they can penetrate every part of the human body, and so insinuate themselves, that it is impossible to get rid of them, at least, there have been instances where many people have been delivered from them only by death. But I see nothing supernatural in this disease, although History would teach us that it has

always been a chastisement reserved for monsters of cruelty and avarice.

We cannot reasonably doubt that insects are the cause of many diseases. Some physicians have even carried the matter so far as to suppose that worms were the cause of all the disorders mankind are liable to. Sturmius maintains that the air is filled with an infinite number of the germs of man, and other animals, so that at each inspiration we inhale a prodigious quantity of them; and unless they transpire through the pores, they engender corruption which is the origin of all diseases. A physician of Paris maintains, that the gout and other diseases which attack the patient in different parts are owing to certain worms which puncture the nerves, sometimes on one side, and sometimes on another. He has not thought it enough to publish his system, but in a particular treatise has pointed out specific remedies, and among the rest mentions another sort of worms which, he says, are an excellent antidote. He avers that they are to be found in plants and minerals, that they must be extracted by means of water, and that after the patient has drunk of this water, the worms it contains will devour those which had produced his disease, and thus cure him. On this subject there is only one desideratum, and that is to know precisely what worms so happily contribute to rid us of those that are so noxious. This Physician boasts of having obtained the secret from a man who professed his art at Ispahan. He assures us that he has studied it with much care, and that after forty years of observation he had reduced it to practice, to the great relief of the afflicted. He adds that this universal medecine has not only acquired a great reputation, by the marvellous effects it has produced in many desperate diseases; but that this precious treasure has cost him a million of livres. If we consult Borrel-

lus

tus, we ſhall be told that the itch proceeds from inſects. A phyſician of Breſlaw refers to the ſame cauſe, the origin of the venereal diſeaſe. But let us return to the French phyſician, and follow him in the explanation he gives of the origin of ague. He lays it down as a principle that it ariſes from a minute febrile animalcule which inſinuates itſelf into the body, either by reſpiration or with the food: that ſo long as it remains quiet, the perſon enjoys eaſe: but no ſooner does this plague awake, than the fits return, and end not till exhauſted with fatigue he falls again into lethargy. It is the ſame with meaſles, and ſmall pox; both conſiſt in a fermentation cauſed by worms corrupting the whole maſs of blood. Even the plague is not an exception from this doctrine: it is maintained that this contagious diſeaſe take its origin from the ſame cauſe, and that animalcules multiplying to exceſs in the air, neceſſarily become a general poiſon.

Although this ſyſtem be countenanced by ſeveral phyſicians, I confeſs it is with difficulty I ſubſcribe to it as a ſettled truth. I would rather take the ſide of of the celebrated Kundmann, whoſe words I ſhall here uſe. " What prodigies might we not expect to ſee " happen from ſuch an hypotheſis! There muſt then " infallibly be worms of every different ſpecies, and " each diſeaſe would have its own; worms for fever, " worms for the cramp; worms for hyſterics; " worms for flatulency, which probably would not " reſemble thoſe for tumour, and which undoubtedly " would diſcover themſelves by the noiſe they " would excite in the bowels; worms for conſumption, for apoplexy, for epilepſy, for madneſs, which " I imagine ſhould be exceedingly alert, if we may " judge by the extravagancies they occaſion; and " and laſtly, how do we know but there may be " worms of every calibre, worms of every ſhape,

"and of every disposition? This is truly a most in-
"genious doctrine, pity it had not more solidity.
"For does it not consider human nature as a fœtus
"on which worms operate diseases as unhealthy mo-
"thers do on their children? Perhaps it will be said
"that these worms cause diseases by the corrupted hu-
"mours they produce, or because they attack or in-
"jure our intestines. But the bad temperament of
"our humours alone, independent of worms, may
"surely produce the same effects, and may not this
"bad temperament take place without being occa-
"sioned by insects? Besides, of how many meta-
"morphoses must not these insects be susceptible? It
"is certain that they ought to change their figure ac-
"cording to the different changes that take place in
"diseases, and to the different events that may fol-
"low from those that are ill cured. Further, I wish
"to know whether in the human body, worms be-
"get indisposition, or are the consequence of it. In
"the last case, the cause of the indisposition not be-
"ing from worms, another cause must be sought;
"in the first, all diseases would originate from in-
"fection, which is not at all probable. For be-
"sides that in swallowing several sorts of worms
"each of which is preparing for the patient its own
"particular disease, he should at the same time la-
"bour under apoplexy, consumption, tenia, small-
"pox, and a thousand other evils which I need not
"name. I am not perhaps single in reprobating a
"system which I take to be the idea of a vision-
"ary, or of a quack, as despicable in the eyes of an
"experienced physician, as the very worms are on
"which the system is founded."

Although I think in the same manner with this au-
thor in general, I do not go so far as to deny the pos-
sibility of finding worms in persons afflicted with ab-
scess, measles, small pox, and other infectious dis-
eases,

cafes. I know that cafes may be brought againſt me, which do not admit of doubt, and I ſhall not raſhly contradict many learned men whoſe experience will always entitle them to reſpect. The following fact happened, I may ſay, under my own eyes. A woman of Nordhauſen, of a ſanguine and choleric temperament, was at the age of eight and forty troubled with an abſceſs, formed on the hypogaſtric region, on the left ſide, immediately under the ribs. A violent fever was ſucceeded by gangrene and afterwards by palſy of the left leg. In this ſituation ſhe applied to Mr John David Plock, who had formerly practiſed ſurgery with Mr D. Cullmus at Dantzick. On the 27th of Auguſt 1734, upon opening the abſceſs he found he had cut through a worm; he afterwards found other two. On the 28th he diſcovered three more, and in the ſpace of three weeks he extracted no leſs than nineteen. Theſe worms perfectly reſembled thoſe that are engendered in the human inteſtines. They were of the thickneſs of a quill, four inches in length, and pointed at the extremities. What are we to conclude from this fact? Shall we ſay that when worms are found in diſeaſed perſons, the diſeaſes are produced by them? By no means, I believe on the contrary, that a part muſt be diſeaſed before worms can lodge themſelves in it. Let me be allowed to explain myſelf: Every naturaliſt knows that among flies there is a particular one which lays its eggs in fleſh, eſpecially when beginning to turn putrid. The inſects when hatched are ſmall, and are provided with a very ſharp pointed inſtrument, which though very tender, is able to penetrate the ſkin. Bodies ſubject to the diſeaſes we are talking of are preciſely ſuch as they go in queſt of. Attracted by the ſmell, they uſe their inſtrument to depoſit their eggs, and as nothing is wanting there to the proceſs of hatching, either in reſpect of warmth or aliment, they live, grow and nouriſh themſelves. Such is my opinion

opinion, of which however I am not ſo tenacious as not to yield to more probable reaſons.

But I alſo believe, that worms are actually the cauſe of ſome diſeaſes. Low and marſhy places are not wholeſome, and whether we live there, or accidentally ſleep by the ſide of ſtanding waters, we ought not to rely on the ſtrength of our conſtitution, eſpecially in warm weather. The ague, and ſeveral other diſeaſes will attack us ſooner or later, occaſioned, partly by worms generated in the mud, partly by vapours riſing from the water, and which we receive in reſpiration. Theſe worms are of ſuch extraordinary minuteneſs, that a moderate degree of the ſun's heat is ſufficient to raiſe them along with the vapour, the parts of which are ſtill heavier, than thoſe they carry up with them. It is probable, that the diſeaſes which prevail in ſuch places, originate from worms, eſpecially as they are moſt virulent in ſummer, which is the ſeaſon of inſects, and as they diſappear in autumn, when theſe ceaſe to live. But by what means do they thus prey on our conſtitution? Do they poiſon us by the acrimony of their ſalts, or do they abridge our days, by devouring the ſolid parts of our frame? Here I honeſtly confeſs my ignorance, and without attempting to ſolve this difficulty, I ſhall only infer the cauſe from the effects, although the manner in which it operates, is to me, altogether a myſtery.

It is likewiſe undoubtedly dangerous to ſwallow certain inſects. There is a ſort of mildew, which is generally met with, at the bottom of the ſtalk of red cabbage. This groſs and ſulphureous exhalation is raiſed by the heat of the ſun, and nouriſhes worms, which are the more to be dreaded, as they are imperceptible to the eye, and, as they often get into the body, along with the food, by the careleſſneſs of thoſe

those who prepare it. Fruits likewise are always subject to the attacks of a species of fly, the eggs and poison of which they conceal. Our relish for this kind of food, prevents us from examining it with proper care, and we eat the bad, as well as the good, at the hazard of a dysentery. I consider this cruel disease, as a necessary consequence of intemperance, as it prevails only at the time when fruits are most plentiful. Animal food, soiled with the excrement of flies, is likewise a most pernicious aliment; and, if it is noxious to swallow insects in substance, along with our drink, it is unpardonably rash to use such food, without having it perfectly purified from all malignity.

I cannot omit to mention, the fatal effects produced by worms upon children, and even upon adult persons. These worms are generated, either by a species of ichneumon, which deposits them in different parts of the body, or they enter by means of every thing we eat or drink, and occasion dreadful changes. Either by pricking or gnawing the nerves and fibres, they produce gout, cramp, and in general, whatever is comprehended under the name of spasmodic contraction. If they are lodged in the stomach, they excite sometimes a false appetite, sometimes an excessive loathing; but generally great sickness, palpitations, vomiting, cold sweats, faintings, languor and suffocation. If, on the other hand, they have got to the head, they are the cause of megrim, syncope and mania; in the throat, shooting pains and nausea; in the urinary passages, diabetes; in the ears, continual singing and pain; in the nostrils, extreme itching, and perpetual inclination to sneeze; in short, they injure the complexion, by making the face pale and wan, and cause, in the extremities of the body, alternate heat and cold: these accidents, however, are but rare; while other diseases hardly ever

ever fail to follow when worms get into the intestines, for which reason, it is proper to say something of that matter here. I am ready to confess, that it is difficult to divine the origin of such insects. To say that they are taken in by inspiration, by food or drink, or by eggs lying in our bowels, either because these worms originated there, or for any other reason whatever, is to say nothing, and each conjecture is attended with more difficulties than proofs. Suppose we should maintain, that these worms were introduced with the air, the question would still remain to be answered, by what means were the seeds of them spread in the atmosphere? why, amongst mankind in general, some should be afflicted with worms, while others are free? and lastly, how it is possible to conceive, that in every person, and every where, these insects have always the same determinate form? Should the entrance of their eggs with our food be maintained, there arises at once, a very natural objection; whence happens it, that there never has been discovered in nature, a worm, similar to those that infest the human body? Besides, is it to be presumed, that the stomach is unable to destroy the eggs of those insects, when it can disorganize substances of the most difficult digestion? I do not mean to enter into the subject, either to investigate the origin of these worms, or to develope their effects when produced.

What is not to be refuted, is, their excessive multiplication in some persons, who have voided vast quantities of them, both by vomit and stool. I shall not mention diarrhæa, tenesmus, stinking breath, starting in sleep, bulimia, atrophy, &c. which are the least of the evils which these insects subject us to; I shall only mention some diseases, which either directly or indirectly proceed from them. Some produce melancholy, tremblings, vertigo; others cholic and asthma,

asthma; many penetrate the viscera, and threaten the patient with premature death; but it is chiefly in violent fevers, that these guests cause the greatest disorders: As this is an acute disease, they throw the patient into convulsions which threaten him with immediate death. How many direful effects of insects in general might we not adduce, were we to collect what has been related! Uladislaus duke of Bohemia lost his life by a fly, which, entering in at his throat, came out at the nape of his neck, and caused an hæmorrhage, which nothing could stop. Adolphus, count of Juliers, was pursued and killed by insects of the same kind. Pope Adrian IV. in drinking, swallowed a fly, which stopped in the passage and suffocated him.

The venomous qualities of many insects spread through the air, and on land, have often proved fatal, both to the timid and the curious, to the prudent and to the rash. It is true, that the cold climates which we inhabit, have this advantage, that insects themselves are not a poison: It is only their sting, or their bite, which is noxious, and not till they are irritated; for then, their vital spirits being violently agitated, there is generated a fermentation in their humours, which thereby contract qualities, exceedingly noxious to the bodies into which they are injected. It has been observed, that these animals are much more fierce in hot than in temperate climates. The reason is evident, the sun acting with much more force in the one than in the other, and attracting more earthy and sulphureous particles, insects acquire humours of a warmer, more pungent, and consequently, of a more malignant quality.

They communicate their venom in various ways; some, by a sort of exhalation from them, infect the air, and whatever breathes in it: others insinuate it

 into

into the parts they touch: others introduce it by means of their teeth; others get into the body by the mouth. The effects they produce on the human body, differ as much as the means by which they attack it are different. The poison of some affects the solids, that of others operates on the chyle; in others it interrupts the circulation of the humours, stops up the pores, or causes other disorders, but their venom, though different in different species, has this in common, that it attacks the nervous and fibrous parts, and there causes violent contractions.

The tarantula is an insect remarkable for the effects produced by its venom, on those who are bitten by it. One dances and leaps, another sheds tears; another sleeps incessantly, another passes the whole night, without closing an eye: One person will tremble through his whole members, without being able to expectorate or perspire; another will grow fond of a particular colour, and never find himself satisfied with looking at it. One person will divert himself with leaping incessantly, or in waving a sword; one will delight in looking at a glass of water, which another cannot endure. One person will take pleasure in a lamb decked with green, while his companion will be in an extacy at the sight of a bason of water, in which he will repeatedly plunge his arm or his head. Some are so elevated with pride, that they speak only in a high style, while others finish their gambols by whining and lamentation: lastly, some fall on the ground, and fight with feet and hands, in a frightful manner.

It is common for insects to associate together in prodigious numbers so as to compose immense armies, and to make all at once an irruption into a country, whither they bring famine and epidemic diseases. I repeat it, that I am not of the opinion of those who maintain

maintain that the plague is owing to indiſpoſition in the human body, cauſed by worms; yet I do not deny but that a vaſt quantity of inſects may give riſe to the plague or other ſimilar diſeaſes. Hiſtory is full of ſuch relations, and, as able philoſophers have found the thing probable, I conſider it as very poſſible. Indeed, when that innumerable multitude of enemies has periſhed and covered the earth with carcaſes, it is natural to ſuppoſe that there will iſſue from them certain volatile particles which being diſperſed through the air, enter into our bodies by reſpiration, and diſturb their economy.

CHAP. III.

Of the injuries which Insects cause to other animals.

Insects do not only make war on other inſects, as we ſee thoſe that are moſt uſeful to man, ſuch as bees, preyed upon by waſps and hornets, but cattle are alſo expoſed to their aſſaults. Inceſſantly attacked by theſe inſatiable creatures, the larger animals receive wounds from their ſting, which penetrate to the blood. Some attach themſelves to the orifice of the wound and ſuck the liquor which diſtils from it; others are not content with a ſingle ſting, but inflict the wound ſeveral times. Such is that ſort of fly whoſe dart is ſtrong enough to pierce the ſkin of theſe animals. There it introduces its eggs, which cauſe thoſe ſtrange tumours

tumours formerly ſuppoſed, by ſuperſtition, to be the effect of ſorcery.

Beaſts likewiſe nourish in their bowels inſects of ſeveral ſorts. Few people are ignorant that horſes which feed in meadows ſwallow worms while they brouze the graſs. Theſe pretty much reſemble the ſeed of a gourd, except that their body is interſected with rings by which they can ſhorten or extend themſelves: they attach themſelves ſtrongly to the ſuperior orifice of the ſtomach of the animal, and move, only to mix with the aliment. Dogs, beſides theſe gourd-ſhaped worms, have likewiſe another kind, which are ſo ſlender, that a great number of them together have the appearance of a clue of thread. Cattle in general are very much affected by worms; they loſe their fleſh, and often die in ſpite of the moſt efficacious remedies. Another poiſon concealed under the graſs, is a ſort of bug called Bupeſtris by Pliny, which makes the body of the animal ſwallowing it ſwell till it burſt. To avoid repetition, I ſhall not here mention any thing of the diſeaſes which leeches cauſe in animals when ſwallowed with their drink; and I ſhall conclude with obſerving that the mortality in ſheep, a circumſtance ſo intereſting to the proprietor and to the ſhepherd, and which too often deceives the vigilance of the one, and the ſkill of the other, proceeds moſt frequently from inſects which devour the liver of theſe animals to ſuch a degree, that the deſtruction of that part neceſſarily cauſes the death of the animal.

CHAP. IV.

CHAP. IV.

THE DEVASTATIONS MADE BY INSECTS ARE SO MANY MARKS OF THE POWER, THE JUSTICE, THE WISDOM, AND EVEN OF THE GOODNESS OF GOD.

OF all the reflections I have hitherto made, none have been aimed so much at atheism as those I propose to introduce in this chapter. I do not doubt but I shall offend its partizans; but if they will for a little unloose the bandage with which they voluntarily blind themselves, and deign for a moment to hear me without prejudice, I do not despair of shewing them truths which they have hitherto been ignorant of. I know that truths are odious to them, and that with them obstinacy is set against reason; however I shall venture to speak to them in its favour. Those who acknowledge the Scripture as a book containing the sacred deposit of the word of God are struck with admiration at the thought of the prodigious number of animals which the power of God collected in the ark. The infidel laughs at this and treats it as a fable: but he does not consider that things equally surprising happen every day under our eyes: do we not see for instance, that certain kinds of insects, after having collected in myriads, sometimes pass over seas, and cause famine and desolation in distant lands? What principle leads them thither? Is

Is it reason or instinct? Be it either the one or the other, I ask the atheist from whence they have received it? If he proceeds step by step it is impossible but he must remount to the supreme cause whence this principle, whatever it may be, originally derives its own existence. But let us go a little farther; these insects, notwithstanding their feeble constitution, carry their depredations into a country affording but a moderate harvest, while they spare another which promised them a much more abundant soil. What is the cause of this election? Is it determined by judgement, or by chance? Neither one nor the other can be attributed to insects, because they are incapable of judgement, and because they act only from a cause determinate and necessary. But once more, what is that cause? It is that which hath bestowed existence on all beings visible and invisible: it is God according to the man of reason; it is chance according to the atheist. I wish much that one of those sublime geniuses who doubt of every thing, even of their own existence, would tell me what is chance. 'It is nothing but a name devoid of sense, a word signifying nothing, a term to cover ignorance, a chimerical being to which is attributed what belongs solely to the powerful Architect of the universe. Atheists accuse us of weakness; but have we not greater reason in this case to treat them as madmen, who adopt the doubtful for the probable, falshood for truth, impossibility for reality? Is it then degrading to acknowledge a God? Is it dangerous to serve him? Is it dishonourable to humanity to believe that he is the creator of mankind? Is it to despoil ourselves of our rights to confess that we are indebted to him for every thing? Is it to rank ourselves with the brutes to allow that it is he who has formed them? It is the province of reason to answer these questions; and if I appeal to conscience I am mistaken, if it would not declare openly that the

wounds

wounds inflicted on us by insects either on our bodies or on the goods we possess, proceed from an Almighty hand which knows when to strike, and which cures when it sees fit. What a shame is it for man that the vilest animals of the earth should teach him to remember God, and to respect his power!

The justice of the supreme being displays itself in the punishment of the crimes of a whole nation. He excites against them voracious enemies which swallow up all expectations from the fruits of the earth. This is founded on the authority of Scripture. Among other maledictions with which the deity threatned the Israelites if they disobeyed his voice, this is not one of the least; DEUT. xxviii. 38. "Thou shalt carry much seed out into the field, but shalt gather little in; for the locust shall consume it." Such in effect was the instrument he made use of to punish the iniquities of that people. JOEL i. 5. "The locust hath eaten what the palmer-worm hath left; and that which the locust hath left, hath the canker-worm eaten; and that which the canker worm hath left, hath the caterpillar eaten." This chastisement was as real as the threat had been positive: but as famine awaited the crime, plenty succeeded repentance; JOEL ii. 25. 26. "I will restore to you the years that the locust hath eaten, the canker-worm and the caterpillar and the palmer-worm, my great army which I sent among you. And ye shall eat in plenty." Of the different plagues with which God visited the Jews, thiswas always one of the most considerable. When the armies and the chiefs trangressed his commands, he sent against them a host of foes which human power was totally unable to resist. "I have smitten you with blasting and mildew; when your gardens and your vineyards, and your figtrees, and your olive trees increased the palmer-worm devoured them. AMOS iv. 9.

The

The Jewiſh nation is not the only one which have been perſecuted by inſects; their ravages have often aſtoniſhed and deſolated the countries of the heathen. After diligently ſearching into the nature and reaſon of ſuch phenomena, nothing appear more probable, than to attribute the cauſe of them to the anger of the Gods. This ſentiment ought to make atheiſts ſuſpect themſelves; the more ſo, as without the aid of Scripture, without any motive of intereſt, without any propenſion but that of the heart, without any lights but thoſe afforded by their own minds, theſe Pagans acknowledged the exiſtence of a Deity in whom reſides the ſupreme right to chaſtiſe vice, and to reward virtue.

If we examine attentively what we ſuffer from inſects, far from finding any thing to blame in the conduct of the Supreme Being, to whom we owe obedience, we ſhall find nothing but ſtriking inſtances of infinite wiſdom. The very fear which theſe animals inſpire us with has its uſes; it ſerves to make us more attentive, more prudent, more careful. They oblige the gardener to provide the proper means for preſerving the precious fruits of his care and toil. Vermin excite us to the cleanlineſs of our perſons; the ſpider to that of our houſes; and the moth to that of our furniture and clothes. Beſides, by a marvellous diſpoſition of Providence, there is not an inſect on the face of the earth whoſe poiſon has the ſame degree of ſtrength on creatures in general; that is, it does not affect all bodies equally as it affects ſome. The caterpillar and ſpider may be fatal to man, while they not only prove delicate morſels to many birds, but even ſpecific remedies againſt their diſeaſes; ſo that it may with truth be ſaid that ſome things which are poiſon to one animal become ſalutary to others. The rule is not even general in the human ſpecies. There are inſtances of people who have

have lost their life by having had the misfortune to swallow insects which others have eaten from a capricious taste without feeling the smallest inconvenience. Such is the profound wisdom of the Creator, who hath introduced into this lower world such admirable order, that the same thing which tends to the prejudice of one contributes to the advantage and happiness of another.

Lastly, the goodness of the first mover is conspicuous in the bounds which he has prescribed to the life of those insects which are dangerous to us. By limiting their duration to a few months, or a few days he has been careful for our peace, as well as for our necessities. For who doubts that instead of momentary evils we would have been subject to perpetual torments, had these animals been generated with us, if they attended us during life, and had survived us or our descendants? One insect which commits depredations can act only in a certain time; another which would eat incessantly is obliged to wait till night before it can appease its hunger; a third seeks its subsistance during the day: but when night comes it can neither find nor devour any thing. What would be the consequence could all these voracious insects satisfy their hunger at all times and in all places? And if they can give us pain, many methods concur to defend us from them, or to prevent their hurting us beyond a certain degree. The openings of the ears, and of the nostrils, for instance, have their natural means of defence. The one is covered with a skin, and furnished with small glands, which exude a bitter substance, disagreeable to insects: the others are furnished with hairs, which cross, and form a sort of barrier, to defend the entrance. Let us add to this, that all countries are not equally favourable to insects. There are some, in which they rather languish than live; some, which do not seem at all

made for them, fending forth vapours, which are abfolutely noxious to them. Even in their favourite regions, they are not protected from many dangers which threaten them. Wind, rain and moifture weaken and kill them, when in their greateft ftrength; fometimes the North wind and froft furprife them in the midft of warm weather, or before they have had time to fortify themfelves againft the approach of winter. Some vegetables are prejudicial to them, certain animals feed on them, and one fpecies of infect fometimes hinders another from multiplying. On the earth the fpider eats the fly, and the chafer the gnat; in the water, the crab devours the leech; on the furface of rivulets, the trout feizes the fly; in the fields and about towns, the fwallow clears the granaries and farm yards; the tom-tit the gardens; the fparrow and the wagtail, the lower grounds. The Lizard and the Chameleon likewife live on infects. Who is there that will not acknowledge in all thefe particulars, an over-ruling providence? Who is there who will not look up to the exiftence of a firft caufe, who hath aranged all things with fuch order and goodnefs, that while fo many infects are of fuch real advantage to us, fo many different animals, and even infects concur in preventing the exceffive multiplication of thofe which might hurt us, fo that in every view, the good overbalances the evil?

CHAP. V.

OF THE PROPER MEANS OF EXTERMINATING INSECTS.

WE have ſeen, in the preceding Chapter, obvious traces of the wiſe conduct of the Deity in the creation and government of this world. Some others remain to be pointed out in the preſent. The faculty which God has beſtowed on man, of contriving different means of defence againſt the injuries cauſed by inſects, is one very evident mark of his beneficence. Nature is a ſchool; but how few people incline to ſtudy at it! We wiſh ourſelves enriched by its treaſures, we wiſh to be ignorant of no myſtery which it teaches; but no ſooner do we encounter its difficulties, than we turn our back and refuſe to return. One is diſcouraged on the road, indolence prevents others from ſetting out. Far from attempting to gain the ſource by a glorious but difficult road, we turn aſide, and content ourſelves with fooliſh fancies, which abſurd cuſtom only hath ſanctioned. And indeed we are at this day ſtill almoſt in the dark with regard to thoſe means by which we may deliver ourſelves from the depredations of inſects. In the Church of Rome, recourſe has been had to different exorciſms, other people have fabricated amulets and taliſmans to which great virtues have been attributed.

Whatever credit these means may have gained with the people, they are far from having the efficacy of prayer, or the worth of the remedies I am about to prescribe. It is true, that it is impossible totally to exterminate insects, both because their number is too great, and because it augments at every instant, by the rapidity with which they multiply.—However, we ought not to despair of finding the means of reducing them in number, or of preventing their excessive multiplication. There are several ways of preventing their increase; the easiest and most natural, in my opinion, are the following. By spreading on the ground, ashes mixed with pigeon's or goat's dung, not only insects newly come forth, but those about to be hatched, are destroyed. To take advantage of the time before insects deposit their eggs, is likewise a very sure way. By destroying the old ones, we rid ourselves of the generation they would have produced; and, we thus perform in an instant, what we would not fail to have been employed in during the whole course of a year. But should the season anticipate our intentions, we must seek their nests in the furrows and clefts of trees. In truth, the industry of insects, in choosing places, in which their brood may be in safety, makes it impossible but some of them must escape our search. They hide their eggs, sometimes under the earth, sometimes under the bark of trees, sometimes in walls; but, if in one province, the country people would use stratagems on their part, it is certain they would ensure that profit, of which they are often frustrated.—There are some husbandmen who plough their grounds in autumn, as soon as the cold begins to be felt. The practice is a good one; for the plough, in opening the soil, throws the eggs of grasshoppers and locusts, and other insects on the surface, where they perish either with the frost, or by rains, or they are eaten by the birds. We cannot defend fruit-

trees

trees from the ravages of caterpillars, better than by carefully pruning them. By this they acquire much more ſap; and, as theſe inſects are not fond of a too abundant juice, they ſeek elſewhere a food more to their taſte. If the approach of winter obliges them to gather together in the neſts which they form at the extremities of the branches, they muſt be taken off, before the ſpring has made any progreſs.

It is poſſible that theſe means may not be practicable at all times; but then, other ſtratagems muſt be fallen upon, to ſtifle the evil in its birth. If caterpillars, ants, and other inſects roam over the ground, and have not yet got upon the trees they are in ſearch of, a ſtratum of aſhes or of chalk muſt be laid at the bottom, which will obſtruct their paſſage. I believe this to be infallible; for beſides, that they are enemies to all conſtraint, they would be ſo embarraſſed by theſe ſubſtances, that they would not be able to diſengage themſelves. Twiſted ſtraw, clay, wool and cotton, are likewiſe ſucceſsful obſtacles to their aſcent. Circles of them are put round the ſtem of the tree, and, if a little reſinous ſubſtance is added to them, the tree will be out of danger. Let us change the caſe, and ſuppoſe that inſects have already got upon the trees, plants, and buſhes, the hand muſt then be employed. But, there are ſome times when this is done with greater ſucceſs than at others, as in the morning, the evening, and during rain. Theſe times are preferable to any other part of the day, becauſe coolneſs and humidity cauſe inſects to collect together, and then they form heaps, which may be cruſhed at once. If, moreover, they have gained the top, and that the height prevents their being reached with the hand, the tree muſt be ſhaken, or a pole, with rags at the end of it, employed to ſweep them off. But expedients muſt be ſuggeſted by circumſtances. There is not a caſe, in which the

the industry of man may not remedy, in whole, or in part, the injuries sustained from insects. Some put honey in water, and place bottles, filled with the mixture, in different places: others put hollow vessels, smooth, and varnished on the inside, among their heaps of fruit and corn. These baits have the happiest effects; the first leads insects to drown themselves; the second entices them to a precipice, over which they fall into the vessel, and then may be thrown into the fire, or into boiling water. Another snare, the success of which is not less happy, for securing fruit-trees, is, to lay the trunk over with glue. The most common artifice, made use of against locusts, is to dig a ditch in the ground, a yard in breadth, and as much in depth. A number of persons are then set to strike the ground from right to left, and continue to drive them, till they fall into the ditch, which is then filled up. The most proper time for this experiment, is the period before they have got wings, or when these are too much wetted with the dew to be used; otherwise, they would take flight and render the labour ineffectual.

Fresh straw, often renewed in a bed, is another secret against fleas, which every body knows, and has an interest in practising for their own repose: however, it is right to mention, that no perfect tranquillity can be expected, while these are allowed to conceal themselves in rough boards. The aversion they have for certain things, is a circumstance which betrays them, and furnishes us with arms for their ruin, as for that of other insects. The greater part hate smoke; and therefore, no sooner feel it, than they fly, or are suffocated, when they cannot avoid it in time. It is therefore probable, that fumigation is noxious to them, especially, if, among the burnt matters, there are any substances whose smell is disagreeable to them; such as amber, orpiment, sulphur,

ur, coriander, black cumin, ſcabious, garlick, wormwood, bdellium, galbanum, myrrh, ſtorax, incenſe, owls feathers, bats dung, hair, horns of quadrupeds, and a number of other things of this nature. We can alſo deſtroy or drive away inſects, by watering the places where they are found, with quick-lime, ſalt diſſolved in water, with dwarf elder, coloquintida, cumin, rue, and other bitter plants boiled; or, with the gall of an ox, diſſolved in water. Beſides fumigation and watering, there are poiſons which kill inſects, ſuch as arſenic, orpiment, hellebore and pepper prepared with common water or milk. Fire and water are of themſelves aſſiſtances as ſpeedy as infallible. To inundate meadows for eight and forty hours, will certainly deſtroy the ants that infeſt it. Boiling water, poured into their holes, not only deſtroys their magazines, but their young. Fire muſt be applied at the proper time, that is, when locuſts and other inſects are ſtill in their unwinged ſtate; then ſtraw laid on the ground, and ſet on fire, will effectually deſtroy them. Gun powder may be uſed againſt flies, by being put into a piſtol, without ramming it, and diſcharging the piſtol, when the flies are collected on ſome ſugar, ſpread on purpoſe, or it may be mixed with bruiſed ſugar, and ſtrowed in a line, and then ſet fire to; but as theſe methods may be attended with ſome danger, they are to be uſed with caution.

We have mentioned above, the wounds inflicted on man and other animals, by different ſorts of inſects; we come now to the proper means of curing them. It often happens, that what cauſes the diſeaſe, affords the remedy, and thus, one inſect ſometimes cures the wound made by another, either by cruſhing it, and applying it to the part affected, or by anointing the part with olive oil, in which a number of the ſame ſpecies has been infuſed. Mud may alſo be uſed as a cataplaſm

plasm, especially when the wound is recent; and, though it may not have the power of effecting a radical cure, yet it may moderate the heat of the part, and so prevent inflammation. Some rather chuse bruised herbs, such as laurel leaves, thyme, savory, marjoram, rue, and other aromatic plants; others prefer urine, with which they carefully bathe the wound.

Mercury is of singular effect, not only for persons troubled with vermin, but for those whose skin, flesh and bowels are affected. This metal is prepared in three different ways; boiled in water, it serves as an apozem; mixed with topical remedies, as an unguent; with purgatives, it becomes physic; and in whatever way it is used, it always produces the desired effect. Another way of curing the same disease, is, to make a decoction of garlic, scordium, lavender, laurel berries, and tamarind leaves, in which the body or parts affected are bathed. A balsam, composed of oil of spikenard and laurel, of hellebore and flowers of sulphur may be substituted for the former. To give them additional strength, little bags, filled with saffron, may be worn under the armpits, or camphor may be applied to the pit of the stomach, not forgetting a frequent change of linen, which has passed through a solution of salt or sea-water. For vermin, which infest those parts which it is indecent to name, the shortest and most tolerable way is, to to use a balsam, made of the juice of wormwood, of scabious, aloes, quick-silver, sulphur, oil of tobacco, and dulcified mercury. For internal remedies, I advise the essence of myrrh, or the tincture of antimony, corrected with the cream of tartar, spirit of hartshorn, elixir proprietatis, essence of centaury, and in short, all those medecines, in which mercury is an ingredient. There are other insects, which are very troublesome, because they appear under the skin of children,

children, in the form of thick and ſhort hairs or briſtles, and ſo cannot be got out, without irritating them. They are diſcovered, and the child cured, by rubbing his back oppoſite to a warm ſtove, or in a bath of honey and garlic. The inſects come forth along with the ſweat, and it is then eaſy to ſcrape them off with a knife, or a cruſt of bread, as ſoon as they ſhew their head. Some, inſtead of this bath, put the children as far as the neck into a lee, in which the dung of fowls has been boiled, and allowing them to ſweat, while they excite the inſects to come out, by rubbing them with their hand dipt in honey. As ſoon as they are ſeen, they are ſcraped off as before, and this muſt be continued two or three days, till no more appear. During this proceſs, it is advantageous to give the patient a doſe of tincture of antimony, or eſſence of myrrh, and to waſh him in water, in which wormwood has been ſteeped, and a ſuitable quantity of aloes.

It is cuſtomary to extirpate worms from the inteſtines, by various ſorts of bitter herbs. The moſt in uſe are the leſſer centaury, camomile, marſh trefoil, feverfew and rue; theſe are boiled in water, and the decoction drunk for ſome time. Things that are ſweet, prove equally efficacious with thoſe that are bitter, provided they be accompanied with wormſeed, or infuſed in hydromel, or encloſed in an apple, a pear, a peach, in prunes, or any thing elſe that children are fond of. If they diſcover repugnance or diſguſt, and refuſe to ſwallow theſe, they are rubbed on them about the navel, and the friction ſerves for what ought to have been taken internally. All ſorts of oil, however, do not anſwer this purpoſe; they muſt be ſuch as have a ſtrong ſmell, and are of a glutinous and bituminous quality, for example, petroleum, oil of amber, and all thoſe which exude from the juniper, the birch, the box, or the hazel

tree. Such things as have a ſtrong taſte, are likewiſe commended, that is, all in which a ſalt prevails, becauſe its acrid nature diſagrees with the worm, and obliges it to leave the body. For this reaſon, I would propoſe ſalt-petre, and ſal-ammoniac; and mineral waters, both cold and hot. The common people are not ignorant of the uſe of theſe. People who inhabit the ſea coaſts, give their children ſea water to drink, and thoſe who live inland, cure them with water uſed in the refining of ſalt. Neither would I reject the vitriolic ſalts obtained from metals, ſuch as ſal martis, and lunar cryſtals. Orange and lemon juice, ſpirit of vitriol, ſpirit of ſalt-petre, and clyſſus of antimony, are beyond every thing in putrid fevers, proceeding from worms: but the doſe muſt be cautiouſly preſcribed, as the too great acidity of theſe remedies would convert the chyle into a ſolid ſubſtance. The riſque of miſtaking, with regard to children at the breaſt, obliges me to warn againſt the conſequences; for whatever the proportion might be, it would not fail to coagulate the milk on their ſtomach. Hartſhorn, ſal ammoniac, and other volatile ſpirits have likewiſe the properties of a vermifuge. The ſame may be ſaid of aſtringents: various experiments on tea, the rind of the pomegranate, and root of the mulberry have long ago brought them into repute. Purgatives, likewiſe, ought not to be rejected, provided they be accompanied with turbeth or jalap, and that care is taken to prepare the patient by ſuitable medecines. If opium be thought proper, or other anodynes, I would ſtrongly recommend caution, for inſtead of a cure, the conſequence might be a fever.

When worms have got into the ſtomach, we ſhould not only proceed in the manner directed above, but they muſt be attracted towards the lower inteſtines, by injections of honey and milk. Dulcified

fied mercury is, in this case, considered as the prime specific; but, in the use of it, two things must be attended to, with great care: First, not to give it in the form of powder, or in too great quantity:—Secondly, to abstain from it, when the duodenum is surcharged with acrimony. In my opinion, it would be best to prescribe it in the form of an electuary, or rather in troches, which seems to be the safest way. But the physician must judge, and prescribe for his patients, according to their age, their strength and constitution: he must find the means of speedily discharging those worms which he has been successful in destroying, lest they become more prejudicial after their death, than they were when alive.

The poison of insects is cured with the assistance of antidotes. If any external part is affected, terra sigillata may be applied, root of gentian, and angelica, leaves of carduus benedictus, sage, rue, juniper berries, oil of citron, serpent stone, scorpion, tarantula, and other venomous insects, provided they are bruised. These are so many emollients and aperitives, but which would not be sufficient for any internal part. Whether the poison of an insect, which has been swallowed, resides in the stomach, or has already mixed with the mass of blood, there is a necessity for counterpoisons, as active and effectual; such as the glossopetræ, cinnabar, oil of almonds, mallows, and wormwood, gentian wine, milk, butter, lard, viper's flesh, oil of scorpions, &c.

Of antidotes in general, none appears to me so singular, as that for the bite of the tarantula. It consists not in the sympathy of animals, nor in the strength of metals, nor in the quintessence of vegetables: it is in music alone that it must be sought. It has so much influence on the affected persons, that it puts all their sluggish members in motion, so that

they get up and dance till they put themselves into a profound sweat, and then fall down in a lethargy. The perspiration continues, during this state of rest, which frees the body from the poison diffused thro' it. Another singularity is, that the same air does not always produce the same effect; various kinds must be tried, till one suited to the quality of the poison is found; there is, however, one favourite air, which is agreeable to almost all the patients; it is called, by the Italians, *l' Aria Turchesca.* Neither is the same instrument of music always used, one patient desiring the tambour, another the flute, the hautboy, the harp, the violin, &c. and each dances and agitates himself, till the strength of the poison is evaporated by the violence of the motion. The difference of symptoms observable in different patients, is observable in the tarantulas themselves. They are of various colours, and when taken, they are placed on thin boards, laid over a vessel of water. At the sound of a musical instrument, some are seen to leap, others remain at rest, according to the difference of their temperament.

Before concluding this chapter, I have to mention one or two other methods of destroying flies. Regulus of arsenic is a most deadly poison to them, and the use of it could not be sufficiently recommended, if it were possible to expect the necessary attention from those employed in preparing it; but, the carelessness of most people, makes me almost inclined to decry this method, notwithstanding its success. I leave it, therefore, to the prudence of those who are acquainted with its effects, and who are cautious in trying the experiment, to provide for the safety of themselves and their families. This poison is given to flies in a cup, or in earthen vessels made on purpose.

In

In 1735 appeared an anonymous work containing the deſcription of an apparatus for deſtroying fleas. In 1729 was publiſhed the third edition of a curious work on a ſort of trap for theſe inſects. The reader may conſult theſe works, and profit from the receipt of Dr Southall an Engliſhman, who acknowledges his having got it from a negro. This receipt has the ſingular effect of attracting the whole fleas in a houſe to the ſame ſpot where their death awaits them.

CHAP. VI.

Of the improper use of Insects in the affairs of life.

When mankind neglect to make a good uſe of reaſon, and give themſelves up to vain and chimerical ſpeculation, there is nothing in nature which they may not pervert into a ſource of deluſion. Every object however which we behold is diſtinctly marked with its own peculiar character which cannot be miſtaken unleſs we willingly deceive ourſelves. This is the caſe of thoſe perſons who preſume to look into futurity, and who apply things to other uſes, than thoſe for which God intended them. Matthiolus tells us that every gall that grows on the oak, if it has not a hole in it, does without exception contain either a fly, or a ſpider or a worm; that the firſt foretokens war, the ſecond

second pestilence, and the third famine. The rage for predicting future events is carried still farther: other visionaries combine the events of the former prophecy and assert that a swarm of locusts is a certain sign, that the country will be afflicted with these three scourges at one and the same time. Nay we have seen people mad enough to maintain that they have read on the wings of these insects characters significant of the above predictions. Ignorance and learning have both contributed to the delusion, there is hardly any thing in life, which does not give notice of something good or bad about to happen. Among our domestic insects there is one that gnaws and beats with so much regularity, that it imitates the beating of a watch, and has accordingly got the name of the death-watch, because when it is heard some foolish people believe that the death of some person in the family will soon happen. To confirm such predictions, examples are produced; but what reliance can he had on proofs so ill founded? When two things happen in succession who hath told us that God meant to point out by the peculiarities of the one, the circumstances that would accompany the other? There have been years in which those insects have excessively abounded, which are considered as ominous, but which however have neither produced war, nor famine, nor pestilence nor unusual mortality. These accidents may have occurred a long time afterwards, but could not therefore be the consequence of those pretended indications. Many people will forego nothing of their prejudices, but obstinately maintain that this effect flows from the cause they attribute it to; but how will they demonstrate the connection? How will they persuade us that those insects which appear in one country have been the forerunners of calamity in another? The world is a great theatre where the scene is perpetually occupied by similar tragedies; so that no time perhaps will

will ever occur in which some state will not be the place of action. Thus superstition can never want a pretext; it will always find means either of predicting truly or of excusing its mistakes.

Merchants likewise make a bad use of insects in commerce. We know in what estimation cochineal is held in the art of dying, on account of the beauty of its colour. Those who trade in that article, often mix it with little red beetles, by which means they make a considerable profit. The trick is as dishonest, as if a merchant should sell wine and water for pure wine. When the dyer comes to make use of his purchase, he obtains no more colour, than is produced by the portion of true cochineal contained in the quantity employed.

Are there not many persons, who flatter their vanity, with the use of silk? Raiment is necessary for man, not only as a covering, but as a defence against the inclemency of the air. But might not leaves, or the skins of animals answer this purpose? The antients contented themselves with these; but, when in course of time, men began to distinguish themselves by magnificent apparel, a thousand ways were invented of ministering to the luxury of dress. It was then that they found the way of drawing threads from many plants, of depriving beasts of their hair and their wool, of undoing the cones of the silkworm; it was then that they fabricated linen and cotton cloths, that they dyed them of all sorts of colours, and dressed themselves, not so much from necessity, as out of prodigality and ostentation. These inventions superseded the simplicity of nature, every thing was changed, and what ought only to have been used to cover the nakedness of man, was made an engine of his pride. Every age had its different fashions, and so much was good taste overstrained

that

that it ended in extravagance. The contagion ſpread far and wide, and perſons, who might have lived eaſily on their eſtate, preferred a ſilken habit to food, and wrapt themſelves in poverty like a ſilk-worm in its cone. Vanity ought ſteadily to be reſiſted; and, if a reaſonable man is expoſed to it, either by his birth or his ſtation, he ought never to loſe ſight of the origin of a pompous exterior. The reflection will fortify him againſt the ſuggeſtions of pride; it will engage him to turn to God, and to cry with ESTHER, xiv. 16. "Thou knoweſt my neceſſity; for I abhor the "ſign of my high eſtate which is upon mine head, "in the days wherein I ſhew myſelf; and that I ab-"hor it as a filthy rag, and that I wear it not, when "I am private by myſelf."

If vanity reigns among men, it domineers in the hearts of women. They not only deck their perſons, with the moſt precious ornaments that art can deviſe, but they endeavour to brighten their complexion in ſpite of nature. Miſſing the grand ſecret of re juveneſcence, they find a remedy for the want of beauty, in artifice and coquetry, and plunder the hives of bees, for wherewithal to efface the ravages of time. Thus, under a maſk, borrowed from the filth of the earth, they endeavour to faſcinate the eye, and inveigle the heart.

The people of Lapland are ſuperſtitiouſly fond of an azure-coloured fly. They carry it about with them as a familiar ſpirit, and think they have ſuch power over it, that, at their command, it will attack cattle, or any perſon they chuſe. The Danes have as abſurd a prepoſſeſſion, in favour of the *Oſcabiorn*. They ſuppoſe, that whoever ſwallows this ſea fiſh, will infallibly ſee his wiſhes accompliſhed.

CHAP. VII.

CHAP. VII.

OF THE ABUSE OF INSECTS IN THEOLOGY.

THE Pagans, in making insects the objects of divine worship, have committed a gross outrage on reason. We imitate such idolators, when we substitute the creature for the Creator; or, when we pay those honours to the work of men's hands, which are due only to God. Let us go back to the early ages of Paganism, and trace the origin of such preposterous blindness. Man, abandoned to himself, is too sensible of his dependance, to doubt that there is a superior Being, to whom he owes love and respect; but, as God is in his nature invisible, and displays himself only by his benefits, man supposes, that he cannot better serve his Benefactor, than by doing him honour, under the form of those objects by which he makes himself known. Thus he came to adore the Sun, the Moon, the Stars, the dead and the living, beasts and insects. St. Paul, in his Epistle to the Romans, Chap. I. 23. proves this; for, when speaking of the Gentiles, he expresses himself thus; "They changed the glory of the uncorruptible God, "into an image made like to corruptible man, and "to birds, and four-footed beasts, and creeping "things." The author of the book of Wisdom, Chap. XI. 15. 16. says the same thing of the Jews, who were punished by the very objects of their foolish worship. "But for the foolish devices of their

"wickedneſs, wherewith ~~being~~ deceived, they wor-
"ſhipped ſerpents void of reaſon, and vile beaſts,
"thou didſt ſend a multitude of unreaſonable
"beaſts upon them for vengeance; that they might
"know that, wherewithal a man ſinneth, by the
"ſame alſo ſhall he be puniſhed."

The Pagans, beſide their ſacrifices, made an offering of honey to their idols, which has made ſome perſons ſuppoſe, that this was the reaſon of the Jews being forbidden to offer any in their ſacrifices. If we may believe Aldrovandus, the inhabitants of Tlaſcala do not leſs abuſe the produce of their bees. They take the wax, and make candles of it, which they offer to their idols in token of ſubmiſſion. Theſe odious practices are not only ſtrengthened by cuſtom, but they have led the way to more criminal exceſſes; for ſolemn feaſts have been inſtituted in honour of inſects. Cælius Rhodiginus mentions a day, ſet apart for the worſhip of crickets, and ſays, that the Pagans of ancient Rome celebrated, with much veneration, the eighth of the calends of December, in order to make theſe falſe deities propitious to their country. So ſuperſtitious were they, that, whenever a ſwarm of bees lighted in the neighbourhood of their city, they conſidered it as polluted, and ſuppoſed it an omen of misfortunes. To ward off theſe, they appointed ſolemn days, in which they deprecated the wrath of their gods: they did ſo, likewiſe, when they believed the graſshoppers unpropitious.

The Jews relate many wonderful things of inſects, but which are conſidered as fables at beſt, by men of ſenſe. It is ſaid, I. Kings vi. 7. that, "in building
"the houſe, (i. e. the temple) it was built of ſtone,
"made ready before it was brought thither; ſo that
"there was neither hammer nor ax, nor any tool of
"iron

" iron heard in the houfe, while it was in building." The Jews, to explain this paffage, have no hefitation in faying, that the workmen employed a worm to fhape the ftones, which infect, named Schamir, cut, and broke them in the places to which it was applied. They add, that it was of the figure of a grain of barley, and that it was kept in a leaden box, becaufe, had it reached any rocks, it would have cleft and deftroyed them. No hiftorian, however, except thofe Rabbis, fpeaks of this prodigy. We have as much difficulty in believing another circumftance they affure us of, namely, that, though in the promifed land, there were multitudes of flies, there were never any within the precincts of the temple, notwithftanding the number of animals facrificed there, that, on the contrary, in the Pagan facrifices, every thing was fo covered with infects, that the chief of their idols was called Beelzebub, that is to fay, the god of flies and gnats. Without waiting to enquire, how far the fire and fmoke might keep infects at a diftance from the altar, I fhall only obferve, that it is not to be believed, that the temple could be abfolutely free of them; the more, as the Scripture makes no mention of this, and the circumftance certainly deferved to be recorded, had it been true. As to the places of the Pagan facrifices, I believe, that flies would crowd to them from all parts, before the fire was put to the victims, becaufe, they would thus follow their natural inclination for the flefh of animals. The Rabbis likewife introduce a number of marvellous adventures in the hiftory of David; among others, that, upon occafion of his retreat to the cave of Adullam, God commanded a fpider to hide the bottom of the cave with her web from Saul, who thus loft the opportunity of feizing his enemy. The manner, in which we know that David furprifed Saul, when encamped on the hill of Hakila, has this additional circumftance, that

David, in order to cut off the skirt of the robe, set his foot between those of Abner, who was asleep by the side of Saul; that Abner having turned himself at this moment, so confined David, that he could not extricate himself, without awaking either the one or the other; that, in this perplexity, God dispatched a fly, which stung Abner in the leg, and thus, not only extricated him, but gave him an opportunity of carrying off the king's halberd, and his cruise of water.

In imitation of the Jews and Pagans, it would seem, that some Christians have also attempted to introduce insects in aid of their religion. J. Baldus, in order to prove the real presence in the Eucharist, relates, that a number of bees having found the host on the ground, paid it homage, and carried it, very respectfully to their hive. Friar Baptiste, of Pisa, in his book *conformitatum vitæ P. Francisci ad vitam I. C.* tells us, that a spider having accidentally fallen into the chalice, while St Francis was saying mass, that holy man chose rather to swallow the spider, than, by throwing it away, to lose one drop of the precious beverage; and he adds, O prodigy! that the spider afterwards came out of the bone of his leg, without doing him any harm. We likewise read, in Nieremberg, that, St Francis walking one day in a garden, saw a grasshopper, which immediately quitted the plant it sat on, and perched upon his hand; that he ordered it to sing the praises of God, and, that with a pretty loud voice, it immediately began a very fine psalm!

CHAP. VIII.

CHAP. VIII.

Of the abuse of Insects in jurisprudence.

Revenge is so sweet that however opposite it may be to the laws of God and man, it is nevertheless very grateful to persons who have not yet learnt to forgive their enemies. They continually lie in wait to disturb the repose of the person they hate, and it is of little importance to them in what way they attack him, provided they accomplish their purpose. This terrible passion finds in nature but too many means of gratification; even insects have often been employed to minister to its fury. There was a time when in Italy this horrid practice was so successfully carried on by means of the poison of a species of hairy caterpillar that it was found necessary to restrain it by the severest laws. The great have not been less inclined to indulge this passion than the common people; and power, and the consciousness of impunity have made them carry resentment to the utmost. In 1126, Henry the young, surnamed the posthumous, Margrave of Metz, &c. had no sooner vanquished the Margrave Conrad the great, than he resolved to tyrannize over a prince whom the success of one battle had put in his power. He committed him prisoner to the castle of Kirchberg, shut him up in an iron cage, and exposed him night and day to the stings of flies and gnats. Sigefroi, Arch-bishop

bishop of Cologne acted in the same cruel way to Adolphus Count of Berg. That prelate was so enslaved by passion, that he forgot his duty to himself and his enemy; he seized his person, contrary to the faith of a solemn promise, and devoted him to be the food of insects; he ordered him to be rubbed over with honey, to be inclosed in a cage, and drawn after him as a part of his retinue, wherever he went. I remember to have somewhere read that a cerain Pagan Emperor, wishing to refine on the punishments inflicted on the Christians, invented one of singular cruelty. He buried the unhappy victim up to the neck in the earth, and leaving the head bare and rubbing the face with honey, abandoned him to the tormenting bites and stings of innumerable insects.

The severity of judges, or barbarity of jailors to their prisoners is a circumstance which I consider as an abuse of their power and consequently as a crime against the law. I speak of those criminals who are allowed to rot in their filth, and who for want of a little straw, are half eaten with vermin before their last hour arrives. I may be told that malefactors worthy of death, are not to be exempted from the hardships of a prison; but where do you find that they ought to be subjected to two punishments at once? The sentence of a criminal is undoubtedly anticipated when the short interval between it and his death is rendered more cruel, and often less supportable than the punishment itself. The conscience of judges should be interested in watching over the conduct of their officers, and in attending to the condition of the unhappy persons whose lives are in their hands.

We are enjoined by the laws to do no injury to any person, whether by hurting his person or his property. The injunction is general, and allows no exception

ception, nor will admit any excuſe, ſo that lawfully we cannot harbour waſps to the prejudice of our neighbour's bees. This caſe appeared ſo important to legiſlators, that they have wiſely impoſed on it the ſevereſt penalties.

Suicide is another crime, condemned equally by divine and human laws. To give up a reaſonable ſelf-love, to renounce our deſire of life, and to make ourſelves the hangman of our own bodies, is in my opinion the moſt enormous abuſe that can be made of reaſon and free agency. This is the caſe of thoſe who have been held up to our admiration for chuſing rather to abridge their days by the empoiſoned juice of ſome vile inſect or reptile, than to ſupport a trifling diſtreſs or a tranſient pain.

However unlimited the power of a ſovereign may be, he degrades his throne, and ſullies his ſceptre if he diſputes the awards of juſtice, or heſitates between cruelty and mercy. When by means of poiſon he gets rid of an innocent or pardonable ſubject, he deſcends from the height of glory to the loweſt degree of abaſement. It is in vain for him to ſweeten the poiſoned draught, that is leſs an act of clemency than a mark of perfidy, and a refinement of cruelty. In this he imitates the ſenate of Athens, who being reſolved to puniſh Socrates, accuſed of Atheiſm, becauſe he believed in one God only, prepared for him a drink agreeable to the taſte, but fatal to life.

CHAP. IX.

CHAP IX.

Of the abuses made of Insects in medecine.

The great end of medecine is to preserve or to restore the health of mankind: to swerve from these principles is an error; to act contrary to them is a crime. The vulgar generally fall into both these faults, having a strong tradition as to the foundation of their belief. Towards St John's day, there is found at the root of several plants, a kind of berry of a purple colour, which is nothing but the web of some beetles. Foolish people imagine it is the fruit of St John, which grows only on that particular day, and which being hung from the roof or bruised on the cloaths, is a preservative from disease, during the rest of the year.

Ignorant quacks, and unexperienced physicians generally fail in cases where others succeed. The reason is plain, because they are unaquainted with the common rules; or if they know them, they know only the entrance, but not the issue. Hence it happens that not having the capacity to prepare medecines, to regulate the doses, or to give them in a convenient vehicle, they lose their patients by those very medecines which would have cured them, if administred by other hands. There are cases in which insects operate with much success; but the cure is never more uncertain, than when we expect it from those presumptuous

presumptuous empirics, who talk of their potable gold, and of the universal medecine. In incurable diseases they are the first and the last to be had recourse to; there they perform their chief feat, and deliver from all ills by precipitating families into mourning. The cases in which remedies, ill applied, have had fatal consequences, are not rare. Insects have sometimes furnished matter for such accidents; as one example, I saw a physician of the kind we have mentioned administer cantharides to a man afflicted with the stone; the patient was immediately seized with the most excruciating pains; he passed blood, gangrene succeeded, and he died. An Italian, whom I shall not name, having taken cantharides, from an opinion generally received, that they provoke to venery, was soon punished for his ill judged temerity. He died in great agony, and upon opening his body, the passages were all found inflamed and ulcerated.

I am sensible, that I here afford to the atheist, but too favourable an opportunity of attacking religion, not to interrupt myself. I think I hear him say, since God, supremely good, and infinitely wise, has created all things, and even insects, for a good end, he ought, for the same reason, to prevent man from employing them to a bad purpose. Either God could not, or would not do this. If he could not, then he is not all-powerful; if he would not, he is deficient in goodness, consequently, he ceases to be God, because he has not all the necessary attributes of deity. This argument is specious, but it is not the less false and unfounded. The attributes of the Supreme Being, are intimately united with his essence, and, therefore, are inseparable. They can never be considered apart, but so united, that the power and the goodness of God, always perfectly accord with his wisdom. It is under this point of view, that, looking at man in the aggregate, we discover,

that the mechanism of his body, is the work of infinite Power, the gift of reason, the effect of inconceivable goodness, and his free will, that of consummate wisdom. Now, if in order to make use of reason, the Deity granted to man, the privilege of free will, it follows, that the Creator could not control the will, without an imputation on his own wisdom, and without annihilating, at the same time, the liberty of the creature. Besides, as it is just to ascribe to God all the good we receive from created things, it would be unjust to attribute to him the ill which results from the abuses we make of them.

CHAP. X.

Of the Prodigies mentioned in Scripture, which relate to Insects.

It is as ridiculous to consider as miraculous, every thing that appears astonishing, as it is impious to deny every sort of miracle. The first betrays ignorance; the second manifests the corruption of the mind, and the heart. This last is the crime of atheists. As a miracle exceeds the power of nature, and, as in order to work one, a superior power is necessary, they attribute this to nature herself, whom they consider, as a being possessed of omnipotence; that is, they maintain that nature can interrupt her own course, and change the laws she hath herself established. Except this, the atheist acknowledges no Supreme Being, consequently, no supernatural effect, but in proportion as we contemplate

contemplate the conftant order that prevails in nature, the determinate ftructure, and multiplication of the different fpecies of animals, and in particular, what I have ftill to fay, with regard to infects; it is impoffible for us not to open our eyes, and acknowledge a Being, all-wife, different from nature, and all-powerful, a Being who hath created the univerfe, who hath regulated and limited the courfe of nature herfelf, who hath fixed the qualities and difpofitions of animals, and who can change, when he thinks fit, the order which he himfelf hath eftablifhed: and, when this truth is once admitted, we can no longer doubt the poffibility of miracles. Accordingly, the Scripture informs us, that they have actually happened, and as its veracity hath been fufficiently demonftrated, its teftimony alone eftablifhes the point.

We read, in Exodus, of various extraordinary events, which undoubtedly furpafs human power. I fhall not here ftop to relate the proofs of the authenticity of the books of Mofes, not only becaufe the fubject would lead me too far, but becaufe others have already fet this in the cleareft light. I fhall only add, that the chaftifement of the ten plagues, inflicted on Egypt, by Mofes and Aaron, in three of which infects were the inftrument of the wrath of God, has been attefted by profane authors. St. Paul, II. Timothy iii. 8. puts Jannes and Jambres in the number of thofe who withftood Mofes, as other writers teftify. Numenius fays, that, when the Ifraelites were driven from Egypt, Jannes and Jambres, the facred writers of the Egyptians, had the reputation of being deeply fkilled in magic; that they were unanimoufly chofen to oppofe their learning to the virtue of Mofes, the leader of the Jewifh people, and that their prayers were fo effectual, as to ftop the progrefs of thofe plagues that had been brought on Pharoah and his fubjects. Though Numenius does not inform

us, that those two magicians were unable to prevent those plagues, he, however, attests the fact. Pliny assures us, that there was a sort of magic known by Moses, by Jambres and Jetopes, and which remained with the Jews, several thousand years after the death of Zoroaster. What he says is obscure, but it shews, however, that the legislator of the Jews was celebrated for his miracles, and that he held a distinguished place among the sages of his time.

Among other plagues which Egypt suffered, the third is remarkable, as it is described in EXODUS viii. 16.---19. "And the Lord said unto Moses, say unto Aaron, stretch out thy rod, and smite the dust of the land, that it may become lice throughout all the land of Egypt. And they did so; for Aaron stretched out his hand with his rod, and smote the dust of the earth, and it became lice in man and beast: all the dust of the land became lice, throughout all the land of Egypt. And the magicians did so with their inchantments, to bring forth lice, but they could not; so there were lice upon man, and upon beast. Then the magicians said unto Pharoah, this is the finger of God; but Pharaoh's heart was hardened, and he hearkened not unto them; as the Lord had said." There is nothing in this miracle, that can be imputed to natural causes; it must be referred to the direction and power of God. The truth of the history is incontestible, not only in itself, but from the authority of many credible authors. Thus, the prophet David had this event in view, when, in speaking of the divine power, he says, in PSALM cv. 30. 31. "He spake, and there came divers sorts of flies and lice in all their coasts." Josephus has also mentioned this in his Jewish Antiquities. God, says he, punished Pharaoh for his wickedness, but with another plague, for he overwhelmed the Egyptians with an innumerable quantity of lice, which so tormented those rebels,

rebels, that they could not get free from them, either by bathing, or anointing themſelves with oil. Even at this day, it is ſaid, the remains of thoſe vermin are found, which the people of the country call Pharaoh's lice. They are a round inſect, of a greyiſh brown colour; ſhining, and of the ſize of a nut; they are greedy of blood, and their bite is intolerable, in a ſhort time extenuating both men and beaſts. We may eaſily conceive, that they in nowiſe reſemble thoſe animals that are engendered by reaſon of uncleanlineſs; we cannot but ſuppoſe, that thoſe of Egypt were raiſed up by the hand that governs nature. Let us examine more particularly, the circumſtances of this prodigy. 1. Aaron was ordered to ſtretch forth his rod, in order to perform it. Is it to be ſuppoſed, that he wrought this miracle, ſolely by the virtue of his rod? 2. Aaron ſtruck the duſt of the earth, and transformed it into lice. It is a fact, now well-known to every naturaliſt, that duſt is incapable of producing any living thing. Not only is it incapable of producing inſects, but it is hurtful to them. We ſee quadrupeds and birds roll themſelves in the duſt, in order to get quit of the vermin that prey on them. 3. It is remarkable, that in all the land of Egypt, the duſt ſuffered this change, at the moment that Aaron executed his orders. Now, though the multiplication of vermin is at all times rapid, yet, that they ſhould extend over the whole country of a large kingdom, that they ſhould attack all the inhabitants, from the king to the meaneſt of his ſubjects, and that they ſhould not ſpare even animals of every kind, is a circumſtance, quite beyond the ordinary operations of nature. 4. If, as David ſays, the whole country ſwarmed with theſe inſects, does it not appear aſtoniſhing, that the neighbouring regions ſhould be free from them? 5. The magicians themſelves confeſſed the impotence of their art, and acknowledged the power of that Maſter who

controled

controled them. God might have chastised Egypt, by abandoning it to the voracity of lions, tygers, wolves, and other wild beasts; but he chose to avenge himself by the vilest of animals; he chose that the Egyptians, who prostrated themselves before altars dedicated to insects, should fall under the scourge of their own contemptible idols; he chose to confound the artifices of Satan, destroy his works, and teach Pharaoh, by the mouths of his own magicians, that there is nothing in the universe, that can withstand his almighty power.

The fourth plague of Egypt differs from the third, only in this, that instead of one insect, there were various kinds. It is said in Exod. viii. 20. "And the Lord said unto Moses, rise up early in the morning and stand before Pharaoh, (lo, he cometh forth to the water,) and say unto him, Thus saith the Lord, let my people go, that they may serve me; else, if thou wilt not let my people go, behold, I will send swarms of flies upon thee, and upon thy servants, and upon thy people, and into thy houses; and the houses of the Egyptians shall be full of swarms of flies, and also the ground whereon they are. And I will sever in that day, the land of Goshen, in which my people dwell, that no swarms of flies shall be there; to the end that thou mayst know, that I am the Lord in the midst of the earth. And I will put a division between my people and thy people; to-morrow shall this sign be. And the Lord did so: and there came a grievous swarm of flies into the house of Pharaoh, and into his servants houses, and into all the land of Egypt: the land was corrupted by reason of the swarm of flies. And Pharaoh called for Moses and for Aaron, and said, Go ye, sacrifice to your God in the land. And Moses said, It is not meet so to do; for we shall sacrifice the abomination of the Egyptians to the Lord our God;

Lo,

Lo, ſhall we ſacrifice the abomination of the Egyptians before their eyes, and will they not ſtone us? We will go three days journey into the wilderneſs, and ſacrifice to the Lord our God, as he ſhall command us. And Pharaoh ſaid, I will let you go, that ye may ſacrifice to the Lord your God in the wilderneſs; only you ſhall not go very far away; intreat for me. And Moſes ſaid, Behold, I go out from thee, and I will entreat the Lord, that the ſwarms of flies may depart from Pharaoh, from his ſervants, and from his people to-morrow; but let not Pharaoh deal deceitfully any more, in not letting the people go, to ſacrifice to the Lord. And Moſes went out from Pharaoh and entreated the Lord. And the Lord did according to the word of Moſes; and he removed the ſwarm of flies from Pharaoh, from his ſervants, and from his people; there remained not one." David alſo certifies this event, in theſe words of PSALM lxxviii. 46. "He gave alſo their increaſe unto the caterpillar, and their labour unto the locuſt." Joſephus confirms the ſame truth, and ſays, that God ſent upon the Egyptians, a number of different inſects, the like of which, no body before had ſeen, and that the whole country was filled with them. This calamity has all the characters of a miracle. 1. Moſes is informed, the evening before, of the time and place where he would find Pharaoh to ſpeak to him, which ſhews the preſcience of the Deity. 2. The puniſhment exactly followed the threat; every thing was overſpread with inſects, except the land of Goſhen, which marks the abſolute power which God exerciſes over the earth. 3. The next day, Moſes delivered Egypt from this plague; an evident ſign of the almighty power of God. 4. The inſects were brought in the ſpace of one night, to a place, in which they are not ſpontaneouſly generated, except by degrees. Their eggs muſt have a certain time before they are hatched, and the caterpillars

undergo

undergo different changes, at different intervals, and lye for many days in the ſtate of a nymph, before they can become perfect flies. This ſhews, that Nature was no way concerned in the working of this miracle. 5. To create millions of inſects, and to deſtroy them, almoſt as ſoon as they were created, certainly could not be the work of men, but of that Being, in whom reſides the power of annihilating the bodies, which he alone can bring into exiſtence.

Locuſts were the eighth plague which afflicted Egypt. We ſhall relate it at length from the tenth Chapter of Exodus. " And the Lord ſaid unto Moſes, go into Pharaoh, for I have hardened his heart, and the heart of his ſervants; that I might ſhew theſe my ſigns before him: And that thou mayſt tell in the ears of thy ſon, and of thy ſons ſon, what things I have wrought in Egypt, and my ſigns which I have done amongſt them; that you may know that I am the Lord. And Moſes and Aaron came in, unto Pharaoh, and ſaid unto him, Thus ſaith the Lord God of the Hebrews, how long wilt thou refuſe to humble thy ſelf before me? Let my people go that they may ſerve me. Elſe if thou refuſe to let my people go, behold to morrow will I bring the locuſts into thy coaſt. And they ſhall cover the face of the earth, that one cannot be able to ſee the earth, and they ſhall eat the reſidue of that which is eſcaped, which remaineth unto you from the hail, and ſhall eat every tree which groweth for you out of the field. And they ſhall fill thy houſes, and the houſes of all thy ſervants, and the houſes of all the Egyptians, which neither thy father, nor thy father's father have ſeen, ſince the day that they were upon the earth unto this day. And he turned himſelf, and went out from Pharaoh. And Pharaoh's ſervants ſaid unto him, how long ſhall this man be a ſnare unto us? Let the men go, that they may ſerve the

the Lord their God: knoweſt thou not yet that Eygpt is deſtroyed? And Moſes and Aaron were brought again unto Pharoah: and he ſaid unto them, go, ſerve the Lord your God, but who are they that ſhall go? And Moſes ſaid, We will go with our young, and with our old, with our ſons, and with our daughters, with our flocks and with our herds will we go; for we muſt hold a feaſt unto the Lord. And he ſaid unto them, Let the Lord be ſo with you, as I will let you go, and your little ones: look to it, for evil is before you. Not ſo, go now ye that are men, and ſerve the Lord, for that you did deſire. And they were driven out from Pharaoh's preſence. And the Lord ſaid unto Moſes, ſtretch out thine hand over the land of Egypt for the locuſts, that they may come up upon the land of Egypt, and eat every herb of the land, even all that the hail hath left. And Moſes ſtretched forth his rod over the land of Egypt, and the Lord brought an eaſt wind upon the land all that day, and all that night, and when it was morning the eaſt wind brought the locuſts, and the locuſts went up over all the land of Egypt, and reſted in all the coaſts of Egypt, very grievous were they, before them, there were no ſuch locuſts, as they neither after them will be ſuch, for they covered the face of the whole earth, ſo that the land was darkened, and they did eat every herb of the land, and all the fruit of the trees, which they had left: and there remained not any green thing in the trees, or in the herbs of the fields through all the land of Egypt. Then Pharaoh called Moſes and Aaron in haſte, and he ſaid I have ſinned againſt the Lord your God, and againſt you; now therefore forgive, I pray thee, my ſin only this once, and intreat the Lord your God, that he may take away from me this death only. And he went out from Pharaoh, and entreated the Lord, and the Lord turned a mighty ſtrong weſt wind which took away

 the

the locusts, and cast them into the Red Sea, there remained not one locust in all the coasts of Egypt." What is there in all this that is not the effect of a power superior to that of nature? 1. Moses and Aaron threaten the King, and in the space of a day, the threat is executed in every point. 2. Moses only stretches forth his hand, and all Egypt changes its appearance. 3. An east wind rises in the evening, blows the whole day, and continues during the night, and yet the insects enter the country only at the appointed time. 4. Locusts appear, but of an extraordinary species which never had been seen before; whereas according to the constant laws of animated beings, it is impossible that one kind can produce any thing but its like. 5. Armies of locusts have been seen ravaging one province or another of a kingdom; but have they ever been known all at once occupying the whole extent of a country? Have insects ever been found so numerous, as to cover the face of the earth, and to obscure the light of day? 6. Locusts quit one field, and light upon another: but here they attack Pharoah in his palace surrounded by his guards; they enter the cabinets of his ministers, they afflict his officers in their houses; they encounter his soldiers in their quarters, and desolate his subjects in their cottages. 7. Those insects in their ravages, always leave what is not agreeable to their taste, or at least what they are unable to use, but in Egypt they devoured every green thing. 8. The author of the Book of Wisdom, Chap. xvi. 9. says that "for them (the Egyptians) the bitings of grasshoppers and flies killed, neither was there found any remedy for their life, for they were worthy to be punished by such." 9. Pharaoh himself confesses this in the prayer he addresses to Moses and Aaron, where he gives these insects the name of *death*. 10. Lastly, there arises a west wind which purifies Egypt, so that there remains nothing of what the contrary wind had brought. This last fact perhaps may be attributed

to

to nature; but there is ſtill in it ſomething miraculous.

We read in the ſixteenth Chapter of Exodus, 19, 20, that Moſes expreſsly prohibited the children of Iſrael from leaving the manna till the morning, and that when, notwithſtanding his prohibition, they kept it, it bred worms and ſtank. We ſee on the contrary. 22. 23, that on the ſixth day, the eve of the Sabbath, they gathered twice as much bread, and preſerved it without its corrupting. I aſk is there any thing like this in the regular and common courſe of Nature? A ſingle day of the week excepted, a day ſo diſtinguiſhed from the reſt of ſo ſhort a period, is undoubtedly a prodigy which confounds the laws of nature. For how is it poſſible that it ſhould rain manna for ſix ſucceeding days, while on the ſeventh there ſhould not fall a ſingle drop? How could it happen that from Monday to Friday an article of food ſhould corrupt in a night, while from Saturday to Sunday, it ſhould remain unchanged?

Let us turn to the twenty third chapter of Exodus where it is ſaid, verſe 28, that if the people of Iſrael would hearken to the voice of God, "he would ſend hornets before them, which ſhould drive out the Hivite, the Canaanite and the Hittite from before them." The promiſe is renewed by Moſes, DEUTR. vii. 20. "Moreover the Lord thy God will ſend the hornet among them, until they that are left and hide themſelves from thee, be deſtroyed." We cannot doubt that God performed what he had promiſed to his people. Joſhua aſſerts it in the laſt ſpeech he pronounced to the tribes of Iſrael. Chap. xxiv. 12. "And I ſent the hornet before you which drave them out from before you, even the two kings of the Amorites; but not with thy ſword or with thy bow."

This is another miracle. That hornets should assault and put to flight the nations of the heathen, and that only the people of Israel should escape from their sting, is unaccountable, except by referring it to the power of the most high.

The book of Jonah, Chap. iv. 5, 6, 7, informs us that the prophet "went out of the city and sat on the east side thereof, and made him a booth and sat under it in the shadow, till he might see what would become of the city." And the Lord prepared a gourd, and made it come up over Jonah, that it might be a shadow over his head, to deliver him from his grief; and that God prepared a worm when the morning rose, and it smote the gourd that it withered." Though it is not miraculous that a worm should devour a plant, we cannot help acknowledging in the growth and destruction of Jonah's gourd a supernatural direction of providence; for in order to convince the prophet that he erred in murmuring against God for having preserved Nineveh, he caused the gourd to grow in a single night, so as to prove a shade to the booth, and to defend it from the extreme heat of the sun; and in the morning, caused a worm to destroy it. Upon Jonah's murmuring at the destruction of the gourd, God takes occasion to say, "Thou wouldst that the gourd had been spared, for the which thou hast not laboured, neither madest it grow; And should not I spare Nineveh, that great city, wherein are more than six score thousand persons?

The fate of Herod, as it is described in Acts xii. 21. 22. 23. is as terrible, as it is incomprehensible in itself. "And upon a set day, Herod, arrayed in royal apparel, sat upon his throne, and made an oration unto them. And the people gave a shout, saying, it is the voice of a god, and not of a man. And

And immediately the Angel of the Lord ſmote him, becauſe he gave not God the glory; and he was eaten of worms, and he gave up the ghoſt." Antiochus periſhed in the ſame manner, being ſtruck by an inviſible hand, " ſo that the worms roſe out of the body of that wicked man, and while he lived in ſorrow and pain, his fleſh fell away, and the filthineſs of his ſmell was noiſome to all his army. And the man that thought a little afore, he could reach to the ſtars of heaven, no man could endure to carry, for his intolerable ſtink." II. Maccab. ix. 9. 10. This is that Antiochus, king of Syria, that tyrant, that monſter, filled with pride, and drunk with the blood of the Iſraelites, whoſe death, as above related, is confirmed by Polybius. He confeſſes, that he was eaten by worms, though he attributes the cauſe to his having conceived the deſign of pillaging the temple of Diana at Elymais; but Joſephus, with more reaſon, aſcribes it to his intention of deſtroying the temple of Jeruſalem. Of what nature thoſe inſects were, is of no conſequence to my argument; it is ſufficient for me, that the Scripture hath declared, that they were eaten of worms: that the firſt was ſtruck by an Angel of the Lord, and that the other, humbled to the earth, ſhewed to all, the avenging hand of God.

NOTES.

NOTES.

PAGE 2, LINE 6.

* *THE most skilful artist.* Artists have indeed executed pieces of mechanism which we cannot enough admire for their design and beauty. Curious instances of these may be seen described by Baier, Derham, Neickel, &c. but when these performances are examined by the microscope, and compared with insects, the difference appears exceedingly striking. By that instrument, the parts appear polished and wrought with the most consummate art; the master-pieces of human ingenuity appear gross and rugged. The interior mechanism of insects, it is impossible for man to imitate, and puts them beyond all comparison.

PAGE 2, l. 17.

The lion is unconscious of his strength. This must be understood, merely of that knowledge which is the result of reflection and reasoning, of which man alone is capable; for as to the knowledge acquired from sensation, it does not appear that this can be denied to brutes, since it is in consequence of sensation alone, that they act. Would the lion, for instance, attack with so much courage, if he were not conscious of the superiority of his strength? or, would the nightingale pass whole hours in singing, if it did not feel pleasure in the exercise of its voice?

PAGE 10.

PAGE 10, l. 20.

**Many curious men.* Here the author enumerates ſeveral collections in Germany, and in Holland; and Mr Lyonet, in a note, mentions one that he had omitted: but, as theſe have now paſſed into other hands, we thought it needleſs to tranſlate this part of the work.

PAGE 11, l. 13.

Maria Sibylla Merian. This lady was a native of Frankfort on the Maine. She acquired a taſte for the ſtudy of inſects, by breeding ſilk- worms. After having ſtudied thoſe of her native place, ſhe went to Nuremberg, where ſhe continued her reſearches. In 1679, ſhe publiſhed the firſt part of her deſcription of European inſects, and in 1683, the ſecond. She afterwards came to the United Provinces, where the ſame animals continued the object of her ſtudies at Frieſeland and Amſterdam. The opportunities ſhe there had, of ſeeing thoſe that were brought from the Indies, inſpired her with the deſire of undertaking a voyage to America. She departed in 1699, for Surinam, where ſhe remained two years, employed in delineating the moſt beautiful inſects of thoſe countries; and, ſhe afterwards publiſhed her work, in a magnificent edition, adorned with plates of exquiſite beauty.

PAGE 11, l. 28.

The edition which was printed. This work contains only the mere delineation of a great number of inſects, without any deſcription. The plates are engraved with taſte; many of the figures give a pretty accurate repreſentation of the originals; but others are very imperfect, and in general, the ſpecific differences are but little attended to. This collection cannot be of great uſe to the naturaliſt, becauſe Hoefnagel did not follow his inſects through their different changes, but contented himſelf with painting them in the ſtate in which chance preſented them to him, without obſerving either order or method.

PAGE 12, l. 9.

Theſe drawings. Among thoſe who have given us repreſentations of inſects, in their different forms, I know none who have performed the taſk ſo well as Mr L'Admiral of Amſterdam. He has begun to publiſh his work on inſects,

ſects, in folio, which will, as he ſuppoſes, contain about 400 pages of letter preſs, and 100 plates. After having painted each animal from nature, he etches them himſelf. The eight plates, which have only yet been publiſhed, are an evidence of his ability, and make us expect with impatience, the performance of his work, which he ſeems at preſent to have diſcontinued. In imitation of Mad. Merian, he propoſes to repreſent each inſect on the plant it uſes for food: if he had ſpared himſelf this trouble, his book would not have been leſs valued by the learned. Theſe ſuperfluous ornaments ſerve but to divert the attention from the principal object; which is in ſome meaſure loſt, when ſurrounded by ſo many acceſſory objects, greater than itſelf; and a treatiſe on inſects, ornamented with ſo many plants, looks more like a botanical performance.

PAGE 13, l. 9.

Twenty five thouſand times. One would ſuppoſe there was here ſome error in the text: for how can we imagine, that the author would mention, as a remarkable circumſtance, a microſcope which magnified twenty five thouſand times, when he ſpeaks afterwards, in this introduction, of a microſcope which magnified ſixteen millions of times?

PAGE 13, l. *laſt.*

Ph. Bonanni. Bonanni did not content himſelf, with treating merely of the wings of inſects: we have of his, a volume in quarto, the firſt part of which contains diffuſe diſcuſſions on equivocal generation, and he does his utmoſt to prove, that corruption may produce living beings. His manner of reaſoning, is ſingular in this, that all his arguments proceed from his ignorance of Natural Hiſtory. He could not conceive, how certain plants, or certain inſects were produced, therefore, they were generated from putrefaction. The gnat, for inſtance, which every body knows, proceeds from an aquatic maggot, generated by other gnats, is produced, according to him, from ſlacked lime: and his argument is, that he does not know, whence gnats are produced, but he has often ſeen them on walls, newly whitened. Is not this an excellent proof, that wet lime can create gnats? and yet, it is his way of reaſoning. After this eſſay, which he might well have ſpared himſelf the trouble of publiſhing, he deſcribes ſeveral ſhells, and then

N n treats

treats of the construction of microscopes, and lastly, speaks of the objects he has examined, with the help of these instruments. It is on this occasion, that he describes the wings of some flies, and the little plumes on those of butterflies. Such is the plan of his work. The plates are indifferent enough, and what he says of insects, appears to me, very superficial.

Page 16, l. 1.

I return to Blancard. The pompous title of this book, and even the manner in which it is here mentioned, would make one believe, that Blancard had treated the subject much more at large than he has done. Would one imagine, that his whole work contains only the description, (and that too, not always compleat,) of seventeen caterpillars, one false caterpillar, twelve maggots which change into flies, and four sorts of gall insects, three beetles, one ephemera, six aphides, one spider, one shelled, and one naked snail, amounting only to forty seven different insects? Mr Frisch, in the preface to his fourth book on insects, reckons only forty six, among which he says, there are only eleven caterpillars. There must be some error in his calculation, or some difference in the editions. But however this may be, the greater part of Blancard's figures are exceedingly well engraved.

Page 16, l. 19.

Frisch. This author is very accurate in his description of the external parts of insects. He does not enter into any anatomical details, but, to make amends for this deficiency, he gives a very faithful history, and often very complete, of a great number of insects, containing many curious and enteresting facts. The number of 300 insects, which he seems to have proposed to publish, has obliged him, in order to make it complete, to give only a mere description of these animals in their perfect state, without any historical detail. His plates, though they do not come from the hand of a master, represent, (at least many of them) their originals, tolerably well. It is to be wished, that the author had treated his subject methodically, and that he had written in a language more generally understood; his work would, in that case, have been much more useful to the world. Each part of that work appeared separately; the first was printed in 1720, and the last in 1738. The whole make a pret-

ty thick quarto volume, and the more instructive, as it contains the description of a very great number of German insects, especially those of the environs of Berlin; and thus facilitates the knowledge of such as are peculiar to that country. His work, however, would have been still more useful, had the author been careful to distinguish the insects he found in the neighbourhood, or in the environs of the place of his residence, from those he may have procured elsewhere.

On this occasion, I cannot help remarking, that it would tend greatly to the advancement of Natural History, if those who publish on insects, would apply to the study of such insects only, as are to be found in the neighbourhood of their own place of residence. This would give them an opportunity of repeating their experiments, as often as they should judge it necessary for the ascertainment of a fact: and, being limited to a small district, they would more easily discover what it contained, and this could not fail of making them find a great number of insects, which are still entirely unknown, and will continue so, as long as people content themselves, with making, in different places, vain and superficial investigations.

I wish also, that those who write on such subjects, would take particular care, to cause each animal be represented of its natural size; to express the outline with accuracy, and to trace minutely, the form and colour of the spots, and to mark with precision, the light and dark parts, that nothing may be wanting, which may serve to characterise the specific differences in the various species of insects, of the same genus.

This circumstance, it must be confessed, has hitherto been very much neglected. There are but very few works which are not liable to some blame in this respect: for, unless a naturalist be himself an able draughtsman, and have the requisite talent, of expressing with accuracy, the nice and delicate characters which distinguish insects of the same genus, it will be very difficult for him to publish any thing of a finished nature on the subject. The persons employed to make such designs, though expert enough in their art, rarely satisfy our expectation. Being accustomed to draw from fancy, and to follow their own manner, to make their subject picturesque, and to improve upon nature, they have not patience to follow her, step by step, in the delineation of an

animal, so despicable in their eyes, as an insect. They grow tired, therefore, in copying so many minutiæ, their attention relaxes, and the work exhibits evident marks of their negligence.

It were to be wished, therefore, that every naturalist were a skilful draughtsman: but as this is impossible, I would require at least, that they knew enough of the art, properly to direct the painters they employ, and to judge of their work as connoisseurs, that they might receive nothing from their hands, except what was correct and well-finished. It is by this means alone, and by that I have already mentioned, that we can ever become able to fix the number of known insects, to understand their history, to determine such as are peculiar to any country, what effects difference of climate produces on them; in a word, to have as general and distinct a knowledge of insects, as we have of other animals and plants; but if these precautions are neglected, authors will give themselves much useless trouble: and even the more that is written on the subject, the more danger there will be, of disseminating uncertainty and confusion, when we descend to particulars. There will, no doubt, be a great number of curious facts brought to light, respecting insects; but, when one shall attempt to verify these facts, by his own experience, he will not know where to find the animal, nor when found, will he know it: and the same animal, represented in ten different works, will appear in each, of a different species; while ten different animals to be found there, might be taken for the same animal. This cannot but load Natural History with a vast number of imaginary insects, while the true species will, for the most part, be unknown.

PAGE. 17. l. 3.

Goedart. The work of this author is to be ranked among those that have plates indifferently engraved, especially those in the French translation. Many insects are there so ill represented that they cannot be known, and those that are known are for the most part so defective that if the detail of their changes and the descriptions that accompany it did not supply the faults of the figure, almost the whole of the plates would become useless. It must be confessed likewise that the descriptions are in general very imperfect; and as Goedart lived at a time

time when the taste for observation and experiment was not yet formed, we must not expect to find in his descriptions that justness and accuracy, which can alone render them fit for establishing the truth of a fact.

Page 17. l. 17.

Mr Lister. The following is Lister's arrangement. He distributes the insects of Goedart into ten sections. The first includes butterflies with erect wings; all that he ranks in this section are day butterflies, and their chrysalids are angular. The second proceed from the caterpilliars called *geometræ*, and have their wings placed horizontally. The third treats of those with hanging wings sitting closer to the body than those of the preceeding sections. The fourth treats of dragon flies. The fifth of Bees. The sixth of beetles. The seventh of grasshoppers. The eight of flies. The ninth of millepieds, and the tenth of spiders. The same author has added short remarks to the observations of Goedart, and has been chiefly at pains to correct him when he has happened to mistake false transformations for natural changes. In other respects his criticisms are not always just: sometimes he finds fault with his author unreasonably; and sometimes when he finds fault with reason, he does not succeed in setting matters to rights. For example let us take his remarks on the third Caterpillar of the first Section. Goedart observes that this caterpillar is one of the spiny kind that live on the elm, and that when it is about to change, it suspends itself by the extremity of the abdomen, and after having quitted its skin, the belly and legs of the chrysalis are found placed by a strange transformation, where the back of the caterpillar formerly was. Lister at first observes here, that he supposes Goedart to have been deceived when he affirms the belly of the chrysalis to be on the side where the back of the caterpillar was, and in this he is right. But when he endeavours to explain how this pretended change of the members of the insect might have taken place, by supposing that it had turned itself round in the dry skin of the chrysalis, and was found thus in a reversed position, he is exceedingly mistaken, for there never happens any displacing in the parts of the caterpillar that is transformed into a chrysalis; and the belly and legs of the chrysalis, are always on the same side that they were on in the caterpillar. What led Goedart into the

the mistake, was that the chrysalis in question, has upon its back a sort of figure of a face which made him take the side where that appearance of a face was for the belly, whereas had he examined more attentively the opposite side, he would have discovered the marks of the legs, the antennæ, and the other parts which are never found but on the side of the belly in a chrysalis. Besides this instance in which Lister finds fault with Goedart justly, without being able to set him right, the same place furnishes another, where he criticises him without any foundation. Lister affirms that the same caterpillar, when it is disposed to change its form, fixes itself to a wall by a single thread, drawn across its body from right to left, and in which it remains suspended. But in this he is mistaken; for the caterpillar in question, as Goedart well observes, suspends itself by its hinder part only. Such as attach themselves to walls by means of a sort of girdle are not of the same species. Besides, properly speaking, the girdle is not composed of a single thread, but is a congeries of many.

The work mentioned here, is not the only one that Lister composed on insects. There is a Latin treatise of his on the spiders of England, another on the shelled snails of the land, and fresh water; a third on the sea-shells of the same country, and a fourth on the petrifactions that are found there. These four treatises, which appear to me better than his remarks on Goedart, form together a quarto volume of 250 Pages, printed at London in 1678.

PAGE 17, l. 21.

Johnston. The figures in his book are still worse than those of Goedart. The butterflies especially are often of an unsufferable deformity, their outlines in general all resemble one another, very few like nature. He meant to range insects in order, but it would have been better that he had not attempted it; or had followed a better method, for according to his, one is obliged in order to know the successive changes of the same animal, to seek for them in different parts of his book, which is very troublesome.

PAGE 18, l. 14.

M. de Reaumur. The work of this author is excellent in its kind, and is by no means undeserving of the encomiums it received from the Journalists of the time. This acade-

micián

mician is perhaps the only one who can truly be ſaid to have perfectly inveſtigated his ſubject, eſpecially in what relates to the induſtry of inſects, and the mechaniſm of their operations. He hath detected them in their moſt ſecret actions, and gives us a moſt accurate account of the ſingular means they employ, in order to attain their ends; and on this part of his ſubject, which is one of the moſt curious in Natural Hiſtory, he deſerves particular praiſe. He enters into details which in general leave nothing more to be deſired. The new ideas which he throws out will be of great ſervice to thoſe who ſhall ever treat the ſubject methodically; and it is probable we ſhall be indebted to him, for the moſt ſyſtematic work on inſects which ſhall appear. The world is ſtill farther obliged to him for communicating the ingenious methods he uſed in the making of ſo many excellent diſcoveries, by which he has put it in every one's power to verify his experiments, and to procure himſelf the pleaſure of ſeeing what he has ſeen.

As to the figures of his work, they are as highly finiſhed as the ſubject requires. As the author did not propoſe to give deſcriptions of the different inſects of the ſame claſs, it was not thought neceſſary that his plates ſhould be better executed than they are.

PAGE 18, l. 18.

They were reprinted in Holland. That edition is in 8vo. The type is ſmall, but the plates are perfectly well imitated. The avarice of ſome of the Dutch bookſellers, who ſold the Paris edition at double price, haſtened this ſecond edition and made the other fall to a moderate price.

PAGE 18, l. 21.

Till the Work is compleat. Mr Leſſer muſt have been ill informed here, or rather Reaumur has altered his purpoſe, for ſix volumes of his memoirs have already been publiſhed.

PAGE 20, l. 9.

General Hiſtory. The work this author has publiſhed under that name, is, properly ſpeaking, only the plan he thought that ſuch a hiſtory ought to be conducted on, as other people have already remarked.

PAGE 20, l. 14.

From Dutch into French. The tranſlator has done it no ſervice

ſervice in the tranſlating; one would not eaſily believe on reading the French tranſlation that the book in Dutch is exceedingly well written.

PAGE 20, l. 19.

He added plates. I have not ſeen the edition of Hennininus; but the whole that the author here attributes to him is to be found in the Dutch edition of 1669, and in the French one of 1685, except that in place of a diſſertation there is one chapter, which treats of the analogy between inſects and plants.

PAGE 21, l. 5.

For the diſſection. It was in the anatomy of inſects that Swammerdam particularly excelled, and that he left all who had purſued the ſame courſe, far behind him. His dexterity in diſſecting theſe ſmall animals ſurpaſſes imagination and borders on the miraculous. His *Biblia Naturæ* is on this ſubject a maſter-piece that will for ever be the object of admiration. But what a pity was it that he ſhould have been born in an age, and in a country where there exiſted ſo little taſte for that kind of knowledge, that not a bookſeller could be found who would print ſo excellent a work! He himſelf had not the means of doing it at his own expence; and he died without reaping the fruit of a labour in which he had waſted his days, and ſpent his fortune.

PAGE 21, l. *penult.*

He called it Biblia Naturæ. If I am not miſtaken this name was given to it by Swammerdam, not by Boerhaave.

PAGE 21, l. *laſt.*

The firſt part contains. The view which Mr Leſſer gives of the diviſion of this work does not appear to me altogether juſt. The Biblia Naturæ is formed on the plan which Swammerdam had laid down to himſelf in his *Hiſtoire generale*, that is, it is divided into four parts, according to the four ſeveral changes which he had obſerved to take place in inſects. In each of theſe parts he begins by explaining the progreſs of the change which he treats of; he then enumerates the inſects which belong to it, and laſtly the Hiſtory of ſeveral of theſe inſects. This is in ſubſtance the plan of his work to which he has added ſome ſeparate eſſays, ſuch as that on the cuttle-fiſh, the frog and the fern.

Although

Although this book bears every where the marks of its author's genius, yet it is impoſſible not to obſerve when reading it, that towards the end he begins to flag, and we ſee with regret, what effects piety when diſturbed by fanaticiſm can produce on a mind exhauſted by application.

PAGE 22, l. 24.

* *Such are the aſſiſtances.* Since the days of the author many excellent works have been publiſhed on inſects, particularly after the ſyſtem of Linneaus appeared, which not only diſpelled the chaos that hung over the whole claſs, but clearly gave the definition of an inſect which had not been done before. Germany eſpecially is rich in publications on this ſubject, which are too numerous to be mentioned here. In England the chief are the Aurelian, or a Natural Hiſtory of Engliſh inſects by M. Harris. LOND. folio, 1766. Illuſtrations of Natural Hiſtory by D. Drury, 4to LOND. 1771, &c.— Barbut's Genera Inſectorum; 4to. The Engliſh Entomologiſt, exhibiting all the Coleopterous inſects found in England; by Thomas Martyn, LOND. 1792. In France a very ſplendid work was begun, intitled Entomologie, ou Hiſtoire Naturelle des Inſectes, of which two large 4to volumes were publiſhed before the Revolution, containing Coleoptera only.

PAGE 25, l. 10.

I will endeavour to diſpoſe my reader. Theſe words are truly worthy of a Chriſtian Philoſopher. This is the proper end which a perſon ought to propoſe to himſelf in the ſtudy of the works of nature, which, without it, is nothing but vain curioſity. We commit an outrage on the Being of Beings, when we ſet ourſelves to contemplate his wonders, without deigning to lift our eyes to their author. As every thing proclaims his greatneſs, and every thing bears the marks of his wiſdom and infinite power, it is blindneſs not to acknowledge him, and it is criminal to acknowledge him without at the ſame time paying him the tribute of our worſhip and adoration.

PAGE 28, l. 29.

A flea never can produce a waſp. A perſon uninſtructed in natural hiſtory, ſeeing that one ſpecies of maggot ſometimes produces different ſorts of flies; and that often ſeveral ſorts of flies proceed from one caterpillar which naturally produces a butterfly, would be led to think that there was nothing but declamation in what the author has advanced and no truth in it. But he would be wrong to judge in this

O o manner

manner. These productions, so monstrous and so uncouth in appearance, are not on that account the less subject to the constant and general law of nature, that each animal produces its like. If we often see insects of the same species, proceeding from animals of a very different kind, it is not that the latter have generated the former; but the females of the one having introduced their eggs into the bodies of the others, the young have been produced from these eggs, and after having fed on the substance of the animal in whose body they were inclosed, issue from it in the form of the insects that had placed them there. These are facts now universally known, and which I have verified by experiments not necessary here to be detailed.

Page 28, l. 33.

They cannot repair the loss. This appears so certain, and is so conformable to the ideas we have of the formation of organised bodies, that one would not expect to find exceptions to the rule. But the author of nature, whose wisdom confounds all our reasoning, in order, as it would seem, to shew us how little we ought to depend on our own powers when we judge of his operations, has created animals which form a very remarkable exception to it, having the singular faculty of reproducing their members whenever they are deprived of them. Sea stars, crabs and lobsters are instances of this, which cannot now be doubted, after what has been related by a naturalist of superior abilities, in the Memoirs of the Royal Academy of Sciences, for the year 1712.

But these instances, and others which I might mention, by no means affect Mr Lesser's reasoning. It is not the sea star, the crab or the lobster that replace the limb they have lost; it is nature which gives it to them, and they contribute as little to the reproduction as we do to that of our nails or our hair.

Page 30, l. 3.

They multiply by generation. It is a general law of nature that animals preserve their species, and multiply in the way of generation. This has never been doubted as to the larger animals, and when insects have been narrowly examined, it has been found that even they whose production seemed the most equivocal, owe likewise their origin to the union of a male and female of the same species. But however general this rule may be, the universality of it is not yet

yet eſtabliſhed. The various ways in which propagation is ſeen to take place among inſects, ſeem to authorize a doubt on this ſubject. There are ſeveral ſorts of thoſe animals formerly claſſed among inſects, ſuch as ſnails and earth-worms, which are both male and female in one individual. We find among true inſects certain ſpecies, the greater part of which are neither male nor female, as bees, waſps and ants. Some are obſerved to engender without coupling, the male contenting himſelf with depoſiting his ſemen on the eggs of the female, as in the Ephemeræ. Some are found which can produce a poſterity for ſeveral generations by a ſingle embrace, as I have diſcovered to be the caſe with the aphides. If we believe Swammerdam on this head, who however gives no ſolid proof of his opinion, there are ſome females among inſects which can be impregnated by the mere ſmell of the male. All theſe various methods of propagation, lead us to preſume that there may be inſects which multiply without reciprocal intercourſe, and without the proceſs of generation ſtrictly ſo called, and where a ſingle individual, by the exertion of its own powers, is ſufficient to propagate its kind; but hitherto no author as far as I know, has demonſtrated the fact by a concluſive experiment. It is true that Leewenhoeck and Ceſtoni thought they had diſcovered ſuch a one among the aphides. Neither they, nor M. de Reaumur ever ſaw them coupling, or could diſcover a male one among the whole ſpecies; all they examined whether winged or not, were always females, and with young even before they had attained their natural ſize. Theſe experiments ſeemed pretty deciſive, and others made by me ſeem ſtill more ſo. Some aphides, taken away at the moment of their birth, and kept ſecluded under glaſſes, in eight or ten days produced young. Theſe young were likewiſe inſtantly removed, and bred up in the ſame ſolitude, produced others nearly after the ſame period, and that production continued long enough to perſuade me, by reaſons ſtronger than thoſe of Leewenhoeck or Ceſtoni, that their opinion was the true one. But having continued my experiments till the ſeaſon when the leaves began to fall, and not having any farther doubt on the ſubject, I was all at once undeceived, when I leaſt expected it. I had collected all the young which my ſolitary aphides had produced, and had eſtabliſhed a little colony of them on the extremity of the branch of a willow which I kept freſh in a glaſs of water. The cold had already made the leaves to wither; but ſeveral of the aphides in the

nymph ſtate, maintained themſelves on it with the reſt, and arrived at their perfect form. One day as I was viſiting them according to cuſtom, I found one of thoſe with wings, ſitting on one without wings. I conſidered this poſition at firſt as the effect of chance, but the tranquillity of the winged aphis, while the other, diſturbed at my approach, was running up and down, made me ſuſpect ſomething. I took a magnifying glaſs, and upon a near examination, found that the poſterior part of the winged inſect, bending down towards that of the other, was intimately connected with the under part of it, and exhibited marks of an union in the common form. This attachment laſted more than an hour, after which the winged inſect flew away. I ſaw the ſame thing happen to many others of the colony, who formed a connection like the firſt; and what perſuaded me that it was a true connubial intercourſe was, that having accidentally cruſhed two of them in that ſituation, while I was examining two others, I found after their death, the extremities of their abdomen ſtill attached. The notion therefore of there being animals which can individually propagate their ſpecies is not yet eſtabliſhed by experiments made on the aphides; let us ſee if it is better founded on thoſe that have been made on the muſcles of freſh waters.

Monſieur Mery in the Memoirs of the Royal Academy of Sciences for the year 1710, aſſerts that it is. He has obſerved four parts in this animal that may ſerve for generation: two of theſe he calls *ovaria*, becauſe they contain eggs, and two he calls *veſiculæ ſeminales*, becauſe in his opinion they contain the ſemen, which is white, and of the appearance of milk. Their ſtructure appears ſimilar, all four terminate in the anus, where he ſays that the two principal ones, as they go out, are united, which is ſufficient for generation; and as he has obſerved in this animal, neither male nor female organ, he thinks himſelf the more authorized to conclude that it is androgynous. But this reaſoning, however juſt it may ſeem, it is not ſo concluſive as M. Mery imagines. The parts which characteriſe the ſexes, may be ſo diſguiſed by their flexibility, by their ſituation and form, in an animal whoſe figure is ſo anomalous as the muſcle, that it is not impoſſible but he may have ſeen them without knowing them; and even though they were actually not to be found, it would not prove that each muſcle was of both ſexes. Neither male nor female organ is to be obſerved in the greater part of fiſhes, but are they on that ac-

count

count both male and female? Besides, though two vessels of the four which terminate in the anus of the muscle, are receptacles of its eggs, it does not follow that the other two are the reservoirs of the semen. The milky fluid they contain, may be destined to another use, than that of fructifying the eggs; it may serve to fix them to the bodies on which the animal deposits them; to envelope them with a substance which may defend them against the immediate action of the water, to afford the young, upon issuing from the egg, a suitable aliment. The eggs of many aquatic insects are surrounded with a clammy matter which they probably owe to such vessels. The glue which makes the eggs of butterflies adhere to the bodies on which we see them fixed, proceeds from two vessels terminating in the rectum, and containing a viscid humour, which is any thing but semen; why then should those of muscles contain it? But even tho' they should contain it, would it follow that muscles were individually sufficient for their own multiplication? By no means. The female butterflies have receptacles which contain semen, and that semen alone is able to fecundate their eggs; these receptacles also terminate in the rectum, and inundate the eggs in their passage. But notwithstanding this, these butterflies must enjoy the company of the male, for it is the male alone who furnishes this semen. May this not also be the case with the river muscles?

If it were certain that the *pholades* never leave the hole they form for themselves at the instant of their birth, as M. de Reaumur maintains, on very plausible grounds (Mem. of the Royal Academy of Sciences 1712) one would be tempted to believe that these shell-fish were sufficient of themselves for procreation, if we did not rather chuse to suppose that their impregnation took place while they were yet in the matrix of their mother, a circumstance we are not hitherto acquainted with an instance of; or perhaps that they have males of another form, and more active than themselves, which visit them in their retreats, as it happens to the gall insects. But if facts so singular as that in question, could be established by mere reasoning, no animal would better deserve to be put among the number of those which are sufficient of themselves to multiply the species than that worm of the human body called *Tænia*, the longest perhaps of all animals, since some of them have been found eighty yards in length, and it is not certain but that some of them may be

still

still longer. This animal according to various authors is solitary, and, as they pretend, is formed in the human fœtus before it is born: it grows up with the person, and there is never more than one found in the body it inhabits. If these circumstances be true, as Hippocrates and his followers assert, what are we to believe concerning the origin of such an animal? For there have never been found, out of the bodies of animals, any thing similar to them, from which we might presume they were derived: and if there had, either great or small, their flat, thin figure, and the vast multitude of articulations they are composed of, would certainly have made them be taken notice of. It must therefore be admitted that these worms are only produced from those that are found in animal bodies; and if so, how could they be generated but on the supposition that each singly is sufficient of itself to produce its like, being always found solitary? and thus we have an instance of our hermaphrodites in the Tænia.

I know that this supposition does not remove all the difficulties attending the origin of this singular worm. It may still be asked why it is always found single, and by what means its eggs or its young enter the body of another person? But it would not be difficult to answer these questions by new suppositions. The first disappears by supposing that this worm is among the number of those that devour one another, the strongest, having eaten up all those produced along with it in the same place, must necessarily remain alone. As to the other difficulty we have only to suppose that the egg or the fœtus of this worm is extremely small, and that the animal deposits it in our chyle, which it may do easily, if the orifice of its ovary is situated near its head, as that of the snail is. From the chyle it will enter into the mass of blood: if it inhabits a woman, the communication her blood has with the fœtus in her womb will introduce the egg or the fœtus of the worm into it by means of the circulation, and the egg and fœtus will begin to grow as soon as it arrives at the place destined for its habitation. If it is harboured in the intestines of a man, then the egg entring the mass of blood, will be carried by the circulation into the vessels where that blood is elaborated, and prepared for a purpose necessary to the preservation of our species; and thus we see easily how it may be mingled with the particles, which enter into the composition of the human fœtus.

this. It is thus that, proceeding on supposition, it is easy to account for every phenomenon, even for the existence of things which have never existed, as those philosophers have done, who have explained to us the way in which putrefaction engenders insects. I have perhaps at present imitated them, by founding, in the instance of the *Tænia solium*, on facts, which, though pretty generally received are not on that account the more worthy of credit. I know at least that Vallisneri, has endeavoured to render them doubtful, and to maintain that the Tænia is nothing but a chain of worms called *Vermes Cucurbitini*, which are linked to one another, and thus form aggregately the figure of a single animal. The reasons he alledges have a good deal of plausibility, and seem so strong that at present a person would be accused of prejudice not to subscribe to his opinion. But I must own they have not entirely convinced me. The difficulties which have occurred to me on the subject, will induce me to neglect no opportunity of endeavouring to discover the truth; and till I have examined the animal alive, which I shall do if I can procure it, I know not whether I shall adopt the opinion of that learned author, or continue of the contrary side.

What has been said sufficiently shews that though it is probable that there may be insects which multiply naturally without the common process by which generation is accomplished, the fact is not yet demonstrated. But what may be advanced as a certain fact, though it has still more the appearance of a paradox is, that there are animals which can be made to multiply, and which in fact do multiply by art, without the common generative process, as we shall have occasion to shew in the sequel.

PAGE 30, l. 14,

Engendered by all sorts of matter. Aristot. Hist. Anim. L. 5. c. 19, Procreantur porro insecta, aut ex animalibus generis ejusdem - - - aut non ex animalibus, sed sponte; alia ex rore qui frondibus insudat; - - - item alia ex cæno et fimo putrescente oriuntur: alia in lignis aut stirpium, aut cæsis: alia in animalium pilis, alia in excrementis, aut jam excretis aut adhuc intra animal contentis. Add. Plin. Hist. Nat. L. 11, cap. 33.

PAGE 31, l. 31,

The covered vessel did not contain any animals. To the ex-

experiments

periments of Rhedi, may be oppofed that made by Leewenhoek, which he relates in his letter of the 14th of July, 1680. He there fays, that he had heard various opinions on the generation of infects: that he had even learnt, that a certain author had maintained, that, if a veffel, containing water and flefh, were carefully fhut, no animal could be produced in it: that this had led him to try the experiment; that, having taken for this purpofe, two tubes of glafs, fhut at the bottom, he had filled them half full of pepper, and had poured on water, fo as to fill the glaffes about three-fourths. It was rain water, recently fallen, and was received into a porcelaine jar, very clean, and which had not been made ufe of for ten years: that having hermetically fealed the top of one of thefe glaffes, and having left only a fmall opening in the other, he examined the water three days afterwards in the open tube, and difcovered in it, a great number of very minute animalcules of different kinds, moving in all directions: that having, on the fifth day, broken off the end of the fealed tube, the air iffued with violence, and he difcovered in the water of this tube, a fpecies of globular animals, larger than the largeft of thofe in the other tube. Here, then, were animals generated, in a place clofely fhut, and where no infects could enter to depofite their eggs: which appears quite contrary to the experiments of Rhedi, and furnifhes an argument in favour of equivocal generation. But, if we attend to the animals which make the fubject of thefe experiments, the difficulty will foon be removed. It is certain, that the experiments of Rhedi were made on thofe maggots that are of a fenfible bulk, and which, without the aid of a magnifier, are every day feen in putrid animal fubftances. His object was to prove, contrary to the opinion of the antients, that thefe maggots were not produced by the corruption of the animal matter, but fprung from eggs which flies had laid in it; and this appeared clearly from the precautions he took to keep off the flies. He contented himfelf, with covering the mouth of the veffel with a thin cloth, a precaution which would have been ufelefs againft infects, incomparably more minute, but which was fufficient to exclude common flies.

The experiment of Leewenhoek, on the contrary, refpects animals of a quite different kind, animals, of which a vaft number may live in a fmall quantity of water: animals which he calls

calls very minute, that is, in his ordinary ſtile, animals, that it would require a million of, nay ten millions, and ſometimes an hundred millions, to compoſe the bulk of a grain of ſand; in a word, animals which one would not ſuppoſe a microſcope could make viſible, had he not taken care to demonſtrate its poſſibility. We eaſily ſee, that the precautions which Leewenhoek took, to exclude ſuch animals from the tube he had ſealed, were by no means ſufficient. Theſe animals or their eggs, might have been, either among the pepper, or in the rain water he employed, or even in the air which filled the void in his tube: there was, therefore, nothing ſurpriſing, in animals being found there, five days afterwards. To overturn, by his experiment, what had been proved by Redi's, Leuwenhoek ought, at leaſt to have boiled the water and the pepper in the very tube, and then to have ſealed it immediately. If he had then found, ſome days afterwards, any animals in that water, his experiment would very much have diſconcerted the modern naturaliſts: but, I am perſuaded, that is what would not have happened.

PAGE 36, l. 29.

From which ſimilar inſects are to be generated. This ingenious compariſon, which ſhews the conformity of inſects with plants, is ſimilar to that made by Swammerdam, in the firſt part of his General Hiſtory, where he compares the developement of the different orders of inſects with the plant called the carnation. The greater animals may, in ſome reſpects, be likewiſe brought into the compariſon of M. Leſſer, ſince all, or at leaſt, many of them, proceed likewiſe from an egg; that all of them increaſe, by means of a nutritive fluid; and that in general, they do not propagate their kind, till they have attained their ultimate perfection. It muſt, however, be confeſſed, that ſome of the analogies which our author diſcovers between inſects and plants, are but imperfect. That, for inſtance, of the wings of inſects with the leaves, ſeems a little far fetched; for, in the firſt place, the leaves appear, almoſt as ſoon as the bud begins to open, while the wings of inſects never make their appearance, till they have attained their perfect ſtate. Secondly, The leaves grow ſlowly after being diſengaged from their gems; but the wings of inſects, after having quitted their covers, elongate themſelves immediately, and acquire their full ſize in a few minutes. Thirdly, the number of leaves in a plant is not fixed; they fall and are renewed, and this

vicissitude lasts as long as the plant itself: but the number of wings in every different insect is invariable, and a wing once lost, can never be supplied. Lastly, according to the conjectures of the most able botanists, the leaves are given to plants, to defend the root and the stem from the heat of the Sun, to facilitate the evaporation of superfluous humidity, and to promote the circulation of the sap, which is to elaborate and prepare the shoots, the fruit and the seeds; while the wings are bestowed on insects, for a very different purpose, to wit, to facilitate their motion from place to place. Besides, if the wings of insects in general, resembled what is said of those of a certain Indian insect, called in that country, the *walking leaf*, (Cicada foliacea; Gryllus siccifolius,) their analogy with the leaves of plants, or at least of trees, would be more remarkable. The wings of these insects, not only in the form and nerves of the wings, resemble the leaves of trees, but in their colour. I have seen some of them with wings of a bright green, others, with wings of a darker green, and like that of a leaf at full growth, and others of the colour of a withered leaf. It is said, that their wings are of the first colour in spring, of the second in summer, and of the last in autumn; that afterwards, they fall, and that the insect remains without wings during the winter, and that they shoot forth again in the spring. If all these circumstances were true, we could not deny, but that the wings of this insect had a very marked analogy with the leaves of trees; but, at the same time, we must allow, that in this respect, it differs from other insects, and is probably unique in its kind; at least, there is not, so far as I know, any other, whose wings are liable to the same vicissitude.

In fine, it may be observed, that the comparison made by the author, between a nymph or chrysalis, from which a perfect animal issues, and a flower-bud, which produces fruit in its maturity, exceeds somewhat, the terms of the parallel in question. His object was to shew the analogy between insects and plants. For this purpose, the author compares the egg of an insect to the seed of a plant, its body to the stem, and its wings to the leaves. It would be necessary, in order to compleat the analogy, to compare some other part of the insect with the flower-bud, but not to compare with it, the entire insect, as he has here done.

PAGE 37, L. 4.

On which they are placed. If Mr Lesser was content, in this

this place, with instancing only one mark of conformity between insects and other animals, it was not for want of more: but, because the one mentioned in the text, is that which distinguishes them most remarkably from vegetables in general. The analogies, however, which subsist between insects and other animals, are very numerous, and in order to mention some of them, I shall observe, first, that both of them grow, and are propagated, almost entirely in the same way. 2. That the internal parts of the one, are analogous to those of the others. All insects, like the larger animals, with few exceptions if any, have a stomach, intestines, a heart, veins, lungs, a brain, spinal marrow, muscles, an ovary, &c. 3. That insects likewise are endowed with senses. All have taste and feeling, the greater part have sight, and probably also smell, nor can it be doubted, that many have hearing. [*The ears of insects have been lately demonstrated by Professor Fabricius, who published an account, with figures of those organs, in the crab and lobster, in the New Copenhagen Transactions, Vol. II. p. 375. That eminent entomologist found the external orifice of the organ in these animals, to be placed between the long and the short antennæ, the cochlea, &c. being lodged in the upper part of what Linnæus calls the thorax, near the base of the serrated projection at its apex. As these animals, therefore, are true insects, it is reasonable to conclude, that the rest of the class are likewise provided with similar organs, in the same places.] 4. That they appear also, to be endowed with the passions, especially with that of love, fear and anger. 5. That they exhibit traces of memory, and a certain degree of intelligence. 6. That each has its peculiar industry, artifice, manner of attack, defence, and method of attending to its own preservation. 7. That a diversity of characters is observable among them. Some are bold, timid, active, slothful, patient, headlong, strong, weak, social, solitary, neat, sluttish, temperate, voracious. In a word, hardly any thing is to be seen in the organs, dispositions, manner of living, and acting in the larger animals, of which we may not find traces in insects; so that it cannot be denied, but that their analogies with these animals, are incomparably more real, and more distinct, than those with plants.

PAGE 39, l. 18.

Approach to the nature of vegetables. Although among in-

 sects,

fects, the greater number feem to be as little allied to the vegetable kingdom, as other animals, it muft, however, be confeffed, that there are fome, which, in external appearance, or in fome other refpect, appear to have a nearer relation to it. Such, for inftance, are the fea anemones (*actinia*) which have rather the figure of a fungus, than of an animal, and which ftir fo little from the ftone they adhere to, that one would think they were rooted in it. Not that they are incapable of progreffive motion; but, it is fo flow, as to be almoft imperceptible, and they hardly move over a fpace of half an inch in a quarter of an hour.

Such, likewife, is the female of thofe animals, called by Reaumur, gall-infects, and which have always been taken in Europe, for real galls. When the female of this infect is with young, fhe becomes incapable of changing place, fhe lofes the figure of an animal, and affumes that of thofe excrefcences, commonly called by the name of galls.

Such, likewife, is that fpecies of tænia, or flat and articulated worm of the human body, whofe head has not been obferved, and which, it is faid, is incapable of motion.— Laftly, fuch is that animal, common in ditches, the form of which, has fome refemblance to the feed of the dandelion, (*Hydra polypus.*)

It is generally fixed by its extremity, to fome other body, without changing place, except very rarely. It has not the appearance of an animated being: if it is cut in two, and even into three parts, each part recovers, and affumes the figure of the whole, and thus, there are two or three animals made out of one. The young iffue from its fides, by a fort of flow and infenfible vegetation, and having grown in this manner, for a certain time, like branches, and having, even themfelves, pufhed out young in the fame way, they are detached from the mother, and live apart. By the greater part of thefe circumftances, one could fcarcely hefitate to rank it among common vegetables; but, when it is more narrowly examined, we perceive, that, when the water around it is agitated, it contracts and draws itfelf in; then expands itfelf again, fo that we begin to think it ought to be claffed above ordinary vegetables, and to be confidered as a fenfitive plant. But, upon ftill narrower infpection, from time to time, when we find, that it is capable of voluntary motion, and that it does not always continue in the fame fpot, but that it tranfports itfelf from one place to another,

nother, by a motion, which, though very flow, is evident, that it even endeavours to get towards the places which are moft enlightened, that the beards which are placed round its anterior extremity, furnifh it, by their vifcidity, with the means of catching the fmall water infects that come in its way, that thefe beards ferve it for arms to carry the infects to its mouth, and that afterwards it fwallows them; we are fenfible, that it is not enongh to place it with the fenfitive plants, but that it muft be acknowledged as a true animal. Befides, the vegetable and animal kingdoms approach each other fo nearly, by means of this equivocal being, that M. Trembley, a very attentive obferver, and who had verified the facts I have juft mentioned, before me, was not able, till after a diligent obfervation of it, for many months, to determine, that it was actually an animal.

Page 39, l. 21.

They are not furnifhed with bones. This obfervation of the author, that infects are deftitute of bones, appears to me pretty juft: I even believe, that one of the beft characters for diftinguifhing infects from other animals, would be their want of an internal fkeleton. It cannot be denied, however, that, if infects have not bones, many of them have parts that anfwer the purpofe of bones. The fnail, for inftance, has, within its body, according to Swammerdam, a ftony tubercle, in which many of the nerves of that animal terminate. Caterpillars, and many other creeping infects have their head defended by a hard fhell-like covering, and often too, a fimilar part above their firft ring or fegment, many of the larvæ that change into beetles, and even the beetles themfelves, the fea eggs, lobfters, crabs, &c. are all armed with a fhell. Lepidopterous infects and all flies have the thorax hard enough to refift moderate preffure. The ichneumons in general, have it very hard; I have feen fome of thefe, whofe thorax was fo hard, that it bent very ftrong pins I wanted to pierce them with. Thefe parts, however, differ from true bones. 1. By being rather fhell-like, ftony or cruftaceous, than offeous. 2. By being placed, (except in the flug) on the outfide of the body, and not in the infide. 3. By being formed in many, if not in all infects, not by a fap which circulates in thefe fhells, but by a fimple appofition of particles, which tranfpire from the body of the animal, and afterwards grow hard. 4. By thefe

fhells

shells being apparently given for a covering or defence.— And 5. By their being so little essential to the internal construction of the body of insects, that it is in a manner demonstrated, that the covers of shell fish are loosened, whenever their enlargement requires that the muscles they are attached by change their place; it is also certain, that many often cast their shells, and that a great number of those that are best armed, exist and act all the time which has preceded their ultimate transformation, without having had any thing of the kind on their body. It would seem, therefore, that the name of bone, cannot be given, with propriety, to those shells or crustaceous coverings. Indeed, this matter is liable to some difficulty, in the case of the slug. Its stony part has been bestowed on it, neither for a covering nor a defence. It seems to exist within the body, merely as a fixed point for the muscles to rest on, and to perform the function of a bone. However, when we consider on one side, that this mass has less the form and substance of a bone, than it has of something lapideous; that besides, it is single in the body of the slug, and only occupies there, a very small space, while the bones, in every animal possessed of them, are found in great numbers, and form, almost always, a skeleton of connected pieces, which support, internally, the whole mass of the body, it does not appear, that this singularity, which takes place in the slug, is sufficient to make it an exception to the rule. I make the same observation, with respect to those cartilaginous parts, which are found internally attached to the calcareous covers of lobsters, and which they quit, when they cast their shells; being nothing but cartilages, and by no means true bones.

I know, that some curious observers, when tearing away from the leg of a flea, the hard part, which covers the articulation next the body, have thought they perceived a bone, in the place which the removal of the hard part had left bare; but I know likewise, that the leg of a flea is an object too small, to allow us to affirm, even with the aid of a microscope, that what we there see, is a bone, and not a nerve, or rather, a part of the very substance of the leg. If there was a bone in the leg of a flea, we should much rather expect to find it in the leg of some larger insect, especially among those whose legs resemble those of the flea, as the grasshopper; but nobody has hitherto discovered any

thing

thing like one in it. Add to this, that the legs of a flea being armed with hard ſhells, it is not eaſy to conceive, of what uſe bones would be to them, theſe ſhells being alone more than ſufficient for ſupporting the action of the nerves and muſcles, and for preventing their limbs from folding between two articulations.

But if, after all, experiment, ſuperior to any reaſoning, ſhould enable us to diſcover true bones in an inſect, this ſingularity, which would approximate the ſtructure of it to that of other animals, would not be ſufficient to remove it from the claſs of inſects; but, as it ſeems eſtabliſhed in nature, that in every kind of created beings, whoſe extremities approach each other, there are always limits which ſeparate them, and that one of the chief, and moſt conſtant of thoſe limits between inſects and other animals, ſeems to be the internal ſkeleton given to the one, and not to the others, it would ſeem, that we cannot, without confounding the claſſes of beings really diſtinct, rank among inſects, any animal, poſſeſſed internally of a ſkeleton formed by a contiguity of bones. I conclude, therefore, that this contiguity alone, is ſufficient to exclude every animal in which it is found, from the number of inſects.

PAGE 39, l. 27.

Whoſe ſubſtance is not fleſh. What the author remarks here in paſſing, to wit, that the ſubſtance of inſects, properly ſpeaking, is not fleſh, may furniſh a ſecond mark for diſtinguiſhing inſects from other animals, that is, that if we find an animal, whoſe ſubſtance does not reſemble fleſh, we may conclude, that it is an inſect. But we muſt not carry this too far; we would fall into miſtakes, were we to conclude, that an animal is not an inſect, becauſe it has a ſubſtance ſimilar to fleſh; for crabs, lobſters, and ſome other animals of the ſame order have actually fleſh, though they are undoubtedly inſects. Beſides, as the queſtion is, how inſects are to be diſtinguiſhed from all other animals, and conſequently alſo, from fiſhes, it is evident, that the expreſſions, fleſh and bones, made uſe of by us, muſt be taken in a very extended ſenſe, in order to comprehend the ſubſtance and bones of fiſhes.

PAGE 39, l. 30.

Inſects are deſtitute of blood. The blood of inſects is not red,

red, and this is a third diſtinctive character. But, as it is very rare to find in Natural Hiſtory, any rules without exceptions, the rule that inſects want red blood, ſuffers an exception, both in the earth worm, whoſe blood has a tinge of red, and in a certain ſhelled ſnail, very common in the ditches in Holland, whoſe blood is purple. Perhaps too, it may be thought another exception to the rule, that many fl es, when they are killed, produce large ſpots, of a very bright and deep red. But it muſt be remarked, that theſe are by no means the blood of the fly. When they were in the maggot ſtate, nothing ſimilar was to be obſerved in them; and when changed into flies, this red matter is not found in their bodies, as it ought neceſſarily to be, were it blood which circulates in their veins. It is only found in their eyes, where it aſſiſts moſt probably the organ of ſight, I know, that blood is ſometimes remarked in the bodies of gnats, and of ſome flies; but, if we attend accurately to the circumſtance, we ſhall find, that it is not to be found, except in the bodies of thoſe gnats and flies, which ſuck the blood of animals; and this blood will be found, only in their ſtomachs, or in their inteſtines: an evident proof, that this blood is that of the animals they attack, as the author has obſerved,

PAGE 40, l. 1,

If we compare inſects. Here is a fourth character, very uſeful as a diſtinguiſhing mark of inſects; for though ſome of them equal, and even ſurpaſs in ſize, the ſmalleſt of the other animals, it may, however, be ſaid, conſidering things in general, that, to deſcend from the greateſt animals to the ſmalleſt, inſects begin nearly where the others end.

To theſe four characters, which reſpect the bodies of inſects, as to ſubſtance and extenſion, we may add five others, which have a reference to their external form, and which are not leſs proper for diſtinguiſhing inſects from the other animals, than the preceding characters. The firſt is mentioned by Mr Leſſer, and conſiſts in this, that the bodies of the greater part of inſects are, as it were, divided by inciſures, which has given riſe to the name they bear. The ſecond, is, that no inſect without wings has only four feet, nor any flying inſect but two. The third, that they have no viſible noſtril, or external ears: but, that they have their organs of reſpiration, either in their thorax or abdomen.

The

The fourth, that the organs of maſtication, or the teeth of ſuch as have any, act from right to left, and from left to right, and not up and down. Laſtly, that their eyes are deſtitute of eye-lids, and that they have neither iris nor pupil. Here, then, are nine characteriſtic marks, by which inſects are diſcriminated from all other animals. They are found in general, applicable to every inſect. But there are many ſpecies, which want one of the laſt mentioned eight characters. The number of thoſe that want two of them is ſmall; perhaps, there may be ſome that want three of them; though I do not know any. If ſuch were to be diſcovered, I would make no difficulty in acknowledging them for inſects; the firſt character, joined to five others, and even with four, would be ſufficient. I would not venture to ſay ſo much, were the firſt character to be wanting, becauſe that appears to me, the fundamental diſcriminating character, that without which no animal can be conſidered as an inſect. But when, after having examined an animal, neither the firſt character, nor any of the other eight, which I have juſt mentioned, are found to belong to it, I think it would be, to confound with improper names, things which Nature has eſſentially diſtinguiſhed, were we to give ſuch an animal the name of inſect. Conſequently, neither frogs, toads, ſerpents, ſnakes, vipers, tortoiſes, lizards, crocodiles, nor other reptiles of that kind, can properly belong to the claſs of inſects, although very able naturaliſts have conſidered them as ſuch, perhaps for want of attending to the characters we have juſt eſtabliſhed. For thoſe animals, far from poſſeſſing all theſe different characters, have few, if any of them. They have bones, which, in almoſt all of them, form a compleat ſkeleton: they have fleſh and blood: the ſmalleſt of them are larger than the generality of inſects; they have no ſenſible inciſures; thoſe which have legs, have four; they breathe through noſtrils; their maxillæ act perpendicularly, and the eyes of the greater part have eye-lids, an iris, and a pupil; in a word, they are in every reſpect, as ſimilar to the larger animals, as they are different from inſects.

But, it will be ſaid, if the animals I have named, belong not to the claſs of inſects, to what claſs muſt they be referred? I anſwer, that as they differ in many reſpects from inſects, and in many other reſpects from the reſt of animals, and that thus, they cannot be claſſed conveniently, under any

of the four established divisions of animals, I would make no difficulty in forming them into a class by themselves, which might be called, for want of a more suitable appellation, the class of reptiles, taking the word, in a sense a little less vague than that which it generally has; so that, according to this idea, all the lower animals might be divided into five general classes, to wit, quadrupeds, birds, fishes, reptiles, and insects.

PAGE 40, l. 2.

The hydra, the crocodile. The author, by opposing the hydra and crocodile, to insects, shews, that he did not consider the reptiles we have been speaking of, as belonging to the class of insects.

PAGE 40, l. 16.

According to Leuwenhoeck. This writer goes still farther, and affirms, that he had found, in the seminal fluid of different animals, such minute animated beings, that a million of them, and sometimes ten millions, would be required to equal the size of a grain of sand. Neither is that all. M. de Malezieux pretends, that he had observed with his own microscope, animals, seven and twenty millions of times smaller than a mite. Hist. of the Royal Acad. of Sciences. 1718.

PAGE 40, l. 27.

The skin of insects is different. As the skin of insects, like that of other animals, varies exceedingly, and as in the one, as well as in the other, some have it soft, hard, rough, smooth, thick, thin, downy, spiny, &c. it does not appear to be in the quality of the skin, that the characters proper for distinguishing insects from other animals are to be sought, but rather perhaps in the divestment of that skin; for it is remarkable that quadrupeds, birds and fishes, never quit their skins, and that the greater part of insects, as well as reptiles, change theirs often.

PAGE 40, Line last.

Composed of several rings. Among insects, some are found that have neither rings nor incisures, such as snails, slugs, &c. but such make but a very small part.

PAGE 41, l. 2.

Deeper than those of the lobster. It would seem here, that M. Lesser

M. Leſſer does not conſider the lobſter as an inſect. But as that animal has no internal ſkeleton, as it has its body divided by inciſures, as it has neither red blood, noſe, ears, nor mouth, nor eyes, ſimilar to thoſe of the other animals, but, as in all theſe reſpects it reſembles inſects, I think we cannot heſitate in fixing it in this claſs, although in ſize, it greatly ſurpaſſes the generality of inſects.

PAGE 41, l. 3.

They have not exactly. If the perfection of an animal were to depend on the number of its external and internal parts, the compariſon, which, in this reſpect, might be made between inſects and other animals, could not fail of turning to the advantage of the former; of this the reader will find convincing proofs in the courſe of this treatiſe.

PAGE 43, l. 1.

Of the diviſion of inſects. It is not ſo eaſy as one would imagine, to form a proper diviſion of inſects. It is not ſufficient to find out ſome diſtinctive differences between ſpecies and ſpecies, and of theſe to make ſo many orders, without troubling ones ſelf, about their being more or leſs eſſential or accidental: the diviſions muſt be founded on the very nature of the things, otherwiſe, they will be more apt to darken, than to illuminate the ſubject. A moſt wonderful order prevails throughout all Nature, compoſed of diverſities and analogies without number. It is this order that we muſt endeavour to diſcover and to follow; it is on the juſt perception of theſe diverſities and analogies, that we muſt found the general and particular diviſions of every ſubject in Natural Hiſtory. But this is a taſk very difficult to fulfil, and without knowledge acquired by long application, it is not eaſy to accompliſh it: accordingly, there are but few naturaliſts, who have attempted to give us a ſyſtematic diviſion of inſects. I am acquainted, only with thoſe of Valiſneri, Swammerdam, Linnæus, and our author. I ſhall take the liberty of making a few obſervations on each of theſe ſyſtems.

I. Valiſneri divides inſects into four claſſes, drawn from the places they are found in. The firſt claſs comprehends, thoſe inſects which live on plants; the ſecond, ſuch as live in water or other fluids; the third, thoſe that live within the earth, or among terreſtrial and ſtony ſubſtances: and the

last, those which live on other animals, or in their bodies. But this division is faulty, in being taken from characters that are rather accidental than essential to insects; and this has made him fall into another much more important error; that of reversing the order of Nature, by comprehending, in one and the same class, insects which have no other relation to one another than that of being found in the same places, while it separates insects which, on account of their essential analogies, ought naturally to have been united. Add to this, that in following the system of Valisneri, we would often find ourselves at a loss to know, in what class to place certain insects, either because they live indifferently in many places, like the onisci, earwigs, and millepieds, which live equally on plants, and among earthy and stony substances, and which, consequently, ought at once to belong both to the first and third class; or because there are others, which, at different periods of their life, live successively in different places. Such are many species of beetles, which live as larvæ in the waters, transform themselves into nymphs in the earth, and afterwards inhabit indifferently, either the water or the air: such are many other beetles, and other coleopterous insects, which live first in the earth, then on plants: and such likewise are the dragon flies, the ephemeræ, gnats, and many different sorts of flies, and even some butterflies, which live first in the water, then in the air, on plants, or animals, and among which are to be found some, that before mounting into the air, have undergone their transformations in the earth. All these insects, and many others, considered according to the different periods of their life, would, in the system of Valisneri, be sometimes of one class, and sometimes of another, and sometimes indeed, in three of the classes at once, which could not but cause a deal of confusion, and which besides, renders his system impracticable.

II. The general division of Swammerdam seems much better imagined. He distributes all insects into four classes, the distinctive characters of which are taken from the nature of the animals themselves. The first comprehends those which are subject to no change of form, and the three others are founded on their different modes of transformation into nymphs and chrysalids. M. Lesser explains them in his VII. chapter, and I shall therefore dispense with detailing them here. I shall only remark, that the great defect

defect in his syſtem is, that the fourth claſs ſeparates from the third, animals of the ſame kind, and which have a much greater reſemblance to one another, than thoſe of different kinds, that conſtitute his third claſs. For while the third claſs is compoſed of lepidopterous inſects, of beetles and flies, animals exceedingly diſtinct from one another, the fourth conſiſts only of flies which are not comprehended in the third. Thus, flies which are animals of one genus, are found ſeparated, and diſtributed into different claſſes, while butterflies and beetles, animals of different kinds, are found united in the ſame claſs. This is certainly a very great defect, and it is further augmented, by Swammerdam's introducing into his fourth claſs, ſeveral flies, which, according to his own principles, ought naturally to have been ranged in the third.

Beſides, as the ſtate of chryſalis and nymph is, with inſects, generally a ſtate of weakneſs, and always of imperfection, and as moreover, it is the ſtate under which they are the leaſt known, and often with moſt difficulty found, becauſe then they are for the moſt part enveloped in a cone, or hid in the earth, or in places where it is not eaſy to find them. I am of opinion, that this ſtate is not a proper one for furniſhing ſuch diſtinctive marks as can be of any utility.

III. Linnæus, in his Syſtema Naturæ, divides inſects into ſeven general claſſes. In the firſt claſs, he places all thoſe which have covered wings, as the different ſorts of beetles: in the ſecond, thoſe that have naked wings, ſuch as butterflies, dragon-flies, ephemeræ, waſps, ichneumons, and other flies. In the third, thoſe which he names half-winged, the character of which is, that they have not all wings, and have no covers to them: in this claſs he enumerates crickets, graſshoppers, ants, bugs, ſcorpions. His fourth claſs comprehends inſects that have no wings but limbs, as the louſe, the flea, the ſpider, the lobſter, the oniſcus, and the millepied. The fifth includes the creeping inſects, whoſe body is naked, and deſtitute of limbs, as the tenia, the earthworm, the leech, the ſlug. The ſixth contains both land and ſea ſhelled animals, and his ſeventh and laſt, ſuch as he names zoophytes, furniſhed with limbs, ſuch as the echinus, ſepia, ſea ſtars, &c.

[*As the ſyſtem here alluded to, was what Linnæus publiſhed in the firſt edition of his Syſtema Naturæ, and which he

he afterwards changed for the beautiful ſyſtem, now almoſt in general uſe, the editor thinks it needleſs to tranſlate M. Lyonet's remarks on it. A general view of that improved ſyſtem, it may not be improper to give in this place.

Linnæus was the firſt who gave the proper definition of an inſect, and that definition has been adopted by all ſucceeding authors. Inſects, according to him, in their perfect ſtate, are animals with many feet, (i. e. more than four) breathing by means of lateral ſpiracles, covered with an oſſeous cruſt, inſtead of ſkin, and their heads furniſhed with moveable antennæ, the organs of ſome kind of ſenſe. He divides the whole claſs of inſects into ſeven orders. The firſt, containing all the inſects that paſs with us, under the general name of beetles, he calls *Coleoptera;* theſe have four wings, the upper divided by a ſtraight longitudinal ſuture, hard, and ſerving as caſes for the more tender under-wings. The ſecond, comprehending all inſects of the bug kind, graſshoppers, &c. he calls *Hemiptera;* theſe have four wings, the two upper not ſo hard as thoſe of the former order, nor divided by a ſtraight ſuture, but lying over each other. The third includes butterflies, and moths; it is called *Lepidoptera*, from the ſmall ſcales which cover the wings. The fourth contains the dragon-flies, ephemeræ, &c. they have four membraneous and tranſparent wings, without any ſting, and are called *Neuroptera*. The fifth includes bees, waſps, &c. which have likewiſe four membraneous wings, and are furniſhed with a ſting; this order has the name of *Hymenoptera*. The ſixth contains all ſorts of flies and inſects with two wings only, and is thence called *Diptera;* and the ſeventh, containing ſpiders, crabs, &c. is called *Aptera*, from their having no wings.]

IV. I come now to the diviſion of our author; and I obſerve, that if he had no other deſign in this chapter, than to reduce to certain heads, the principal diverſities in the forms of inſects, nothing could hinder us from admitting his ſyſtem; but, if in place of this, his intention was to give us a general plan of the diviſions of inſects, to ſerve as a rule to thoſe who ſhould propoſe to treat of them methodically, and to give their hiſtory compleat, I cannot enter into his ideas.

His firſt diviſion diſtinguiſhes inſects into thoſe with wings, and thoſe without wings. But of what uſe is this diviſion, when it is allowed, that inſects in general, are pro-

duced from the egg without wings, and that it is not, till after having passed the greater part of their lives in this state, that they acquire the power of flying? If the author understood, as Linnæus does, by insects without wings, such as never have any, and by those with wings, such as get them sooner or later, his division might be received; but this is not the case. He ranks among the insects without wings, those which having lived for a certain time without wings, acquire them afterwards, such as caterpillars, and various larvæ, which change into flies and beetles; so that an insect which is placed in one of his general divisions to-day, may belong to the other to-morrow, which makes his system confused, and more likely to lead to error, than to order.

He afterwards subdivides unwinged insects into those which have legs, and those which have none. But this second division has another defect, which we have taken notice of in two of the preceeding systems, to wit, that of including in one class, animals of very different appearance, while it distributes into different classes, animals of very similar forms. We shall find, for example, the snails which undergo no transformations, united with various sorts of maggots, which are changed into flies, while those pseudo-caterpillars, which also change into flies, (i. e. tenthredos) are separated, and placed in the other division.

The author next distributes unwinged insects with legs into different classes, according to the number of their legs; but this division labours under the same defect, that of separating animals, that resemble one another, and of conjoining dissimilar ones. We shall find, for example, caterpillars with sixteen, fourteen, twelve, and ten feet, although they all change into lepidopteræ, separated into so many classes, according to the number of their feet, while the caterpillar with ten feet, will be found included in the same class with some spiders, and those spiders will be separated from those that have only eight feet, which last, will, in their turn, be conjoined with mites and other animals, which have no resemblance to them in form. After having thus made some subordinate divisions of unwinged insects, the author goes on to those that have wings. Here he succeeds better; but as insects, considered before the time when they receive their wings, have already been arranged by our author, under different classes, which have no relation to those he as-

signs

ſigns them, after having acquired wings, a naturaliſt who propoſed to follow M. Leſſer's diviſion, would find himſelf very much embarraſſed, to conciliate the two ſorts of diviſions of the ſame inſects ſo oppoſite to one another. He would be obliged to abandon one of them, unleſs he rather choſe to follow the injudicious manner of Johnſton, and to treat ſeparately of the ſame animals, firſt as creeping, and then as winged inſects.

I hope theſe few remarks will be ſufficient to ſhew that many inconveniences would ariſe from adopting any of the four ſyſtems of inſects, I have now mentioned. At the ſame time we cannot but be ſurpriſed to ſee a ſcience which has been treated of, even ſince the days of Ariſtotle, make ſo little progreſs, as never to have hitherto been properly ſyſtematiſed. We would almoſt be tempted to believe the thing impoſſible, if it were not more reaſonable to think that the defect proceeds from few people having given themſelves the trouble of reflecting on it. And this ought to induce all who ſtudy inſects to turn their attention to the ſubject, as a good ſyſtematic diviſion is what the ſcience ſtands moſt in need of. The information which may be drawn from thoſe authors who have not ſucceeded will ſerve to guide thoſe who ſhall undertake it after them. In order to make the attempt more eaſy, I have ventured to point out the faults of thoſe ſyſtems which have been already deviſed. The ſmall experience I have in the matter prevents me from entring the liſts myſelf; but if I were allowed to ſpeak my own ſentiments of the ſubject I think that of all the general characters which diſtinguiſh inſects, none is ſo proper to furniſh a firſt diviſion as that remarkable difference, to wit that ſome undergo transformations, and others always preſerve the ſame figure they had at firſt. This diverſity ſuppoſes in them a diſpoſition of organs, an internal ſtructure, a mechaniſm ſo different that I believe nothing can more eſſentially diſtinguiſh them. According to this idea, then, we may arrange all inſects into two claſſes; the firſt comprehending ſuch as undergo no metamorphoſis; the ſecond thoſe which appear ſucceſſively under different forms.

The firſt diviſion thus eſtabliſhed would furniſh a vaſt field for as many ſubdiviſions as the nature of the ſubject might require. I do not deſign to detail theſe here, but ſhall content myſelf with giving one example, following a ſingle

single branch, by which I shall descend to a particular species among those that are best known.

The second class may be divided into two principal genera. The one will comprehend insects which undergo a partial external change of form; that is a change which is not so compleat but that there remain marks more or less distinct of their former figure. The other will contain those whose external change of form is so total and compleat, that no traces of their former figure can be perceived. These last will be of three sorts; insects which change into beetles, those which are transformed into flies, and those which become butterflies or moths. The insects of this last sort will consist of caterpillars properly so called and Spanners. (Geometræ) The Spanners will be either of a regular or of an irregular figure. The irregulars will be either those with twelve feet or those which depart from the cylindrical shape by turgescences or protuberances, and thus of the rest.

Although I propose this first idea of the general divisions as what appears to me the most natural and the most practicable, it is not to be supposed that I give it as exempt from faults. I am persuaded that difficulties will appear in every system that can be formed. The author of nature, wishing as it were to shew that he is above the laws and rules he hath himself established, seems sometimes designedly to depart from them; hence it happens that however general the rules are on which a system is founded, there will always be found exceptions which will render that system imperfect in proportion to their number. Sometimes these exceptions are of so singular a kind, that it is impossible to foresee them, and nothing but experience can demonstrate them. Not to speak of any but such as I consider as difficulties in my own plan, who would suppose that among insects of the same species, and which is still more remarkable of the same sex, there would be found some who never change their form, and consequently belong to the first division, while others undergo a transformation, which by making them acquire wings, transfers them to the second division? This would appear singular, and yet the aphides, insects in many respects remarkable, afford many examples of it. Who would think that there were insects, the females of which suffer no transformation, while the male suffers a total change of form? Of this however we find an example in the glow-worm, the male of which is of the beetle kind, and the

female a creeping insect with six feet, which has scarcely any resemblance to it. It is likewise one of the most general rules, that all proper caterpillars become butterflies or moths and yet among them we find many species where the male alone turns into a perfect insect of that kind, the female changing into a dull ill-shaped animal without wings. The rule is that all maggots subject to a change are metamorphosed either into flies or beetles; and yet the flea, though it springs from a maggot, is neither the one nor the other. The ant likewise comes from a maggot, and yet few of them become winged. All these singularities are so many difficulties which occur in the plan I have sketched, as they do in many instances in the systems of Swammerdam, Linnaeus and Lesser; but as difficulties of this kind will always be unavoidable in every system which attempts a natural order, because the rules of that order however general they may be, are seldom universal; there is no other way but that of endeavouring to reconcile such difficulties with the plan devised. This may be done by assigning to insects of a doubtful class, that class in which the individuals are found, which are the most perfect of their species; and to insects which belong properly to no division, that to which they have the nearest relation. Thus the winged aphides which from this circumstance are the most perfect of their species, belong to the second general class in our system. According to my division, I would have no difficulty in comprehending every species of aphis in this second class. For the same reason, the female glow worm would be found among the beetles with their males, and the unwinged lepidopteræ, should be ranged in the same class with the males; the winged ants would bring the whole species to the class of flies, and the relation which the flea has in many respects with beetles, would make it take its station at the end of the animals of that order. In this manner might difficulties be obviated, and a methodical arrangement facilitated.

PAGE 43, l. *last*.

The Gordius. This is an aquatic worm. There are some terrestrial animals, which deserve as well as this to be called thread-worms. Caterpillars nourish some of them in their intestines. I have seen some issue of different lengths from more than one species of caterpillars that feed on the alder. A caterpillar of the length of an inch, furnished me with one

one ten inches long, and which was not nearly ſo thick as the firſt ſtring of a violin. This worm ſo much reſembled a piece of cat-gut, that if one did not ſee it move, one could hardly believe it was an animal.

PAGE 44, l. 2.

The Water Tipulæ. This muſt be ſome particular ſpecies for in general the water Tipulæ have feet: and what is uncommon, and what no one has as yet obſerved, I know ſome of them which may be ſaid to be a kind of quadruped. They have two kinds of legs or crutches at the anterior part of their body, and two at the hinder part. Theſe legs, which is another ſingularity, are ſtiff and without joints. The anterior ones, a third ſingularity, inſtead of being provided each with a pointed nail, are armed with a circle of hooks, and both feet are moved at once, but with a motion always parallel and uniform from top to bottom, and vice verſa. I know not whether the poſterior ones be moveable; I have always found them ſtiff like ſticks. If the four limbs I have juſt mentioned, can be called true feet, this inſect will make an exception to the rule I laid down in the preceeding Chapter, to wit, that no creeping inſect is a quadruped.

PAGE 44, l. 7.

Hippocampus. As the fulcra of this little animal form a perfect ſkeleton, it ought rather to be conſidered as a fiſh than as an inſect.

PAGE 44, l. 21.

Even the inteſtines of animals. Of all animals, none perhaps are ſo liable to nouriſh worms in their inteſtines as inſects. The ichneumons, which are of many different ſpecies, derive their origin for the moſt part from larvæ which have fed on other inſects and deſtroyed them.

PAGE 44, l. 31.

I know a ſpecies of water flea. It is far from being certain that there are any inſects with only two feet. None ſuch are found among thoſe that live on land. God ſeems to have diſtinguiſhed by this character men and birds from the reſt of terreſtrial animals. It is not even very certain that there are bipeds among the aquatic inſects. Thoſe that

pass for such are the pulices aquatici, mentioned by the author, and the larva of the (*Asilus*) but if we examine accurately what are supposed to be the feet of both these animals, we will find that, as to the Pulex aquaticus, they are rather a sort of oars, which the animal uses in its progressive motion, than true feet: for far from having the form of feet, they are two trunks placed near the head. They divide each of them into two branches whence other smaller branches issue which circumstances do not agree with the idea we have of feet, nor indeed are they fit for performing the functions of feet. But even though these oars should pass for true feet, the same pulices seem to have others under the belly, which from their minuteness seem to have escaped the observation of Lesser, and which prevent these animals from being considered as bipeds. As to the larva of the Asilus, what would have been its feet are two short articulated members, two sorts of beards which issue from the sides of its mouth. Their situation and minuteness ought rather to make them pass for beards than for feet, although Swammerdam affirms that they are cases for the extremities of the feet of the future fly. Moreover this animal when arrived at its perfect state, has six legs, and accordingly it cannot with propriety be classed with bipeds. But if insects have not hitherto furnished us with certain examples of animals with two feet, one would perhaps be surprised to hear that they furnish us frequently with examples of those that have but one. However strange this may appear, we do not hesitate, with M. Reaumur, to mention a great number of Bivalve shelled animals possessing a muscular organ which they extend a great way beyond their shells. This organ is their foot, and they use it in transporting themselves from place to place.

PAGE 45, l. 3.

The Formicaleo. It is no doubt from the resemblance in the name, that the Formicaleo is placed among the Formicæ or ants, these insects resembling each other in nothing else. The first in form rather looks like a spider; it devours ants and is therefore called formicaleo.

* Linnæus calls it Myrmeleon Formicarium.

PAGE 45, l. 20.

Land and water Scorpions. The flat and winged Cimex commonly

commonly named the water ſcorpion has only ſix feet. The land ones, at leaſt ſuch of the ſpecies as are known to me, have ten feet, counting the two large fore feet which are armed with claws or pincers.

PAGE 45, l. 24.

The caterpillars called geometræ. Theſe caterpillars have generally ten feet. The ſpecies that have twelve are very rare. I know but three ſorts. None have been found, ſo far as I know, which have eight feet, though a firſt rate naturaliſt ſuppoſes there may be ſuch.

PAGE 45, l. 25.

The common caterpillars. Theſe have ſixteen feet, comprehending the two hinder ones; but the author, it would ſeem does not count them, I know not for what reaſon, ſince he reckons the hinder ones of the geometræ among their feet. It is even the more neceſſary that theſe ſhould be reckoned in the common caterpillars becauſe there is a ſort of caterpillars with fourteen feet, that have no hind ones. Theſe, with regard to the number of their feet, would be confounded with the common caterpillars if the poſterior feet of ſuch as have them were not to be counted. Beſides, the caterpillars which want the hind feet, there are alſo ſome other ſpecies which do not want them, and yet have only fourteen feet. Theſe, and the former are the only ones that can be ranked in the claſs which the author here ſpeaks of.

PAGE 45, l. 27.

We obſerve eighteen feet. There is no true caterpillar known which has eighteen feet. Thoſe which have more than ſixteen and which reſemble caterpillars are as M. de Reaumur names them pſeudo-caterpillars, that is, ſuch as though pretty ſimilar to caterpillars are not really ſo, as they naturally change into flies with four wings (Ichneumons or Tenthredos) while the true caterpillars change into butterflies or moths. If there be any pſeudo-caterpillars with eighteen feet, they muſt be very rare, for I have never found any. All thoſe I have ſeen had twenty or twenty-two feet, and indeed that which Leſſer here ſpeaks of, on the authority of Mad. Merian has really twenty by her account. But I ſuſpect very much that ſhe has been deceived

as

as she says that it produced a phalena. This would be an unexampled case, and two singular to be credited on the authority of a person more intent on painting insects than in describing them exactly. There is every reason to believe that she had mistaken the chrysalis of a true caterpillar for that of the pseudo-caterpillar in question; and I imagine that she made a similar mistake in Part II. Nº 3. of her European insects, where she says, that a butterfly came from a caterpillar with twenty-four feet.

PAGE 45, l. 32.

Beetle with a proboscis. This likewise would be a singular fact in Natural History if it were true, I do not believe that any naturalist has ever seen a larva with four and twenty-feet producing a beetle, nor indeed does Mad. Merian, whom M. Lesser quotes here as his authority, say that the animal in question had four and twenty feet. It is in the description of the third and not of the second plate of her second part that she speaks of an ochre-coloured larva found in rotten wood, which changes into a beetle. Some lines above she had spoken of a caterpillar with twenty-four feet. These two descriptions are printed close together in my Edition, and occupy only ten lines. The author has probably read the first four lines, where she speaks of the four and twenty feet of her pretended caterpillar, and then skipping two or three lines has read what she says of the larva of the beetle. Without further consideration, he must have taken the pseudo caterpillar and this larva for one and the same animal; and has given to the larva the feet of the pseudo-caterpillar: without this explanation, it is impossible to comprehend how he could quote the authority of Mad. Merian for bestowing four and twenty feet on a larva not mentioned by her.

PAGE 46, l. 2.

One hundred and eighty four feet. This number of feet cannot but appear very considerable to those who reflect on the multitude of springs, which must enter into the internal construction of so small an animal, in order to put so many machines in motion. But after this with what astonishment will we not be struck at the sight of an animal which has fifteen hundred and twenty feet, as one species of sea stars has. What do I say? even two thousand one hundred,

dred, as a ſpecies of Echinus has, according to M. de Reaumur. See Memoires de l'Academie Royale des Sciences, 1710, and 1712. Beſides this prodigious number of feet, theſe Echini, according to the ſame author, have thirteen hundred horns, ſimilar to thoſe of ſnails, which they can put out and draw in at pleaſure, and from the extremities of which, they expreſs a kind of glue, by which they attach themſelves to the bodies they want to fix on, that they may not be carried away by the agitation of the water of the ſea.

PAGE 46, l. 17.

Thoſe that eat other inſects. All flies whoſe maggots eat inſects, are not flies with two wings. The greater part have four which are called Ichneumon flies, and M. Leſſer himſelf places them among the inſects with four wings. Theſe inſects have borrowed the name of Ichneumon from a certain amphibious rat of Egypt ſo called. This rat deſtroys the egg of the crocodile, and it is ſaid it can find its way into the belly of that animal to prey upon its liver.

PAGE 46, l. 20.

* The Ricinus volans. This is the Hippoboſca equina of Linnaeus.

PAGE 47, l. 4.

A powder ſtrewed over them. This powder ſeen in the microſcope conſiſts of flat laminæ or plates of a regular figure. Their anterior edge is generally indented like the teeth of a ſaw, and their poſterior extremity terminates in a point. They have likewiſe pretty often different ſides. Some of theſe plates likewiſe are channelled; I know ſome that have ſixty furrows. This powder or rather theſe plates are not ſcattered at random on the wings of lepidopterous inſects; they are there ranged with a great deal of art, and laid over one another like tiles on a houſe. Each plate is inſerted by its apex, into the membraneous and tranſparent part of the wing, and the aſſemblage of their different colours forms thoſe beautiful ſhades which we admire in them.

PAGE 47, l. 5.

Have four wings. It is ſo general a rule that all lepidopterous inſects have four wings, that one would be inclined to believe it without any exception. But I have found a

caterpillar

caterpillar of the Geometræ kind, about ſeven lines long, of a pale green colour, with a head compreſſed and forked, and with two points at the extremity of its abdomen, which produced a well formed butterfly, having, beſides the four wings common to all butterflies, between its upper and under wings, two ſmaller ones, ciliated and folded double. Indeed they did not ſeem to have been of great uſe to it in flying, but they certainly deſerved the name of wings, as they had all the appearance of them. As I have never obſerved more than one caterpillar of that ſpecies, I ſhall not decide whether this ſingularity was a luſus naturæ, or a character peculiar to that ſpecies. I know however that inſects afford few examples of monſters with more members than are neceſſary for them, and this makes me think that the ſix wings might be natural to the ſpecies I mentioned.

Page 50, l. 13.

Sea-Stars. It would ſeem that Mr Leſſer conſiders Sea-Stars as animals without feet. The rays of ſome of them may however well be conſidered as ſuch, ſince there are ſpecies which move them, and uſe them for walking; but even though this ſhould not be the caſe, there are Sea-ſtars that have rays provided with a great number of feet as we have already remarked. As to thoſe ſpecies, they cannot be ranked among inſects deſtitute of feet. Beſides, in the author's enumeration, he has forgot to mention ſnails, ſlugs and many ſhelled animals which would conſiderably have augmented his liſt.

Page 50, l. 15.

The claſs of inſects with two feet. See what has been ſaid on theſe different claſſes in the preceeding Chapter.

Although Mr Leſſer's Catalogue of inſects be pretty conſiderable, it is however far from comprehending all the inſects known. He confines his claſs of butterflies to the number of 135; but Mad. Merian alone has diſcovered upwards of 260, including thoſe of Surinam. I have, in leſs than four years, found above 340 ſpecies of butterflies, in the ſpace of about a league in circuit; and I do not doubt but a little application will furniſh me with many more.

Page 51, l. 4.

And ſo progreſſively. Mr Leſſer gives us here but a vague idea

idea of the multiplication of insects. As something more decisive, I shall relate an experiment I made on the subject. Although one of the most common, it will give us a more accurate idea than that in the text. The Experiment was made with the moth figured by Goedart Part 1. Exp. 59, (Phalæna antiqua.) A nest of about 350 eggs, which I had from a single female of this moth, produced as many little caterpillars. As it would have been inconvenient to have fed so many, I took only eighty, which I brought up. All of them underwent their transformations, and came to their perfect state, except five which died. Amongst all these however I had but fifteen females; whether the males are naturally less numerous in this species, or whether it happened by chance I know not. But let us suppose for a moment that it always happens so, I reason in this manner: If eighty eggs gave fifteen prolific females, the nest of 350 would have given at least 65. These 65 females, supposing them as fertile as their mother, would have produced in the second generation 22,750 caterpillars, among which there would have been at least 4265 females, which again would have given birth to 1,492,750 caterpillars for the third generation, a number greater than according to Mr Lesser's calculation, the third generation of all his 765 different insects. Besides, the caterpillar I am talking of is not one of the most prolific. I know some that produce double the number at least. And what is this in comparison with certain viviparous flies, which produce towards 20,000 young, at a single birth; of which consequently a single fly, supposing the number of females equal to that of the males, would produce at the third generation a posterity of two thousand million of millions? Let a person form to himself, if he can, an idea of the prodigious number of flies which at the end of a few years a single fly of this kind would produce, had not Providence taken care to limit the progress of such astonishing fecundity. But what shall we say when we consider, that God created in the first of these animals, a faculty sufficient for the production of many thousand generations of their kind, which should continue to succeed each other to the end of the world, and of which each individual female seems to possess the power of multiplication in so enormous a degree? Certainly those who think that all reproduction is performed by developement, will here find themselves perplexed, and will be

obliged to acknowledge that if their system is plausible on one hand, on the other it is founded on suppositions which we cannot conceive to be possible, since for this purpose, we must be able to comprehend how the original parent fly we are speaking of, contained, in its body, such a prodigious number of young, that when arrived at their full growth, and united together, they would form, if I may venture to say so, a mass greater than would be produced by the accumulated matter of all the globes in the visible hemisphere. But this is not the only marvellous circumstance. As each young one when inclosed in the parent fly, is at least thirty thousand times smaller than its mother, and as we must suppose that each young one contains germs at least thirty thousand times smaller than it is itself, and so of the rest; here is a new sort of progression, still more marvellous than the first, by which each fly, in proportion as we consider it a step nearer to its first parent, will diminish much more in size than it is encreased in number, at each generation: so that the maggot of such a fly which is at present thirty thousand times smaller than its mother, was three hundred million of times smaller a generation before; and three thousand million of millions of times smaller two generations before. Let any one judge after this of the infinite minuteness of such a maggot, according to this system, some thousands of generations back. It would need, in supposing that flies generate only once a year, at least twenty-two thousand figures ranged consecutively, to express arthimetically, how many times smaller than a fly of its species it was, when inclosed in the common mother of the species. If in this system of developement we should suppose that it is in the animalculæ of the male semen, that the source of multiplication is to be sought, the wonder would greatly encrease: for these animalculæ are much less in proportion to the males, than the fœtuses of flies are to the female.

Page 51, l. 6.

I have made no mention of maggots, caterpillars, &c. The reason of this is plain. All the winged insects here enumerated, having been formerly maggots, caterpillars or other creeping larvæ, could not be reckoned as maggots, caterpillars, &c. and then as winged insects without counting them twice.

Note

Page 52, l. 7.

Food for other animals. It is not only among other animals that insects meet with enemies; they destroy one another. The Formica-leo (Myrmeleon formicarium) devours ants, the Hemerobius perla and a great number of larvæ feed on all sorts of aphides; spiders eat flies, and are themselves killed by wasps, and other voracious flies. The tree bugs, various larvæ which change into beetles, and many beetles and flies devour caterpillars, pseudo-caterpillars, maggots, butterflies, and moths; some species of caterpillars eat one another. The ichneumon flies of many species destroy an infinity of larvæ by laying their eggs in them which produce young, that prey on the vitals of the animal which harbours them. The carnage is still greater among aquatic insects; of these there is hardly a species which is not, at some period of its life, a prey to some bolder or stronger insect.

Page 20, l. 9.

* Locusts which lay waste the fields, have the tail too short to be able to lay their eggs deep in the earth: accordingly, birds and the injuries of the elements destroy them in great numbers; a wise ordination of Providence, to prevent the excessive multiplication of so noxious an animal!

Page 46, l. 6.

Every thing which lives respires. Although this is a most general rule, it is not perhaps without exception in insects. Many have given me reason to doubt of their respiration, at least in certain stages of their existence. I took for instance some of those large cantharides of the willow, whose strong smell, though not very disagreeable, is felt at a considerable distance. I put them under a glass, where for a long time sulphur had been burning on a piece of copper made red hot, that the sulphur might continue to burn in the midst of its own vapours; and although there arose so thick a smoke that it almost hid my insects from sight, they supported these vapours for more than half an hour without suffering, that I could perceive, the smallest injury.

Besides, when we consider the solidity of the greatest part of the cones made by the pseudo-caterpillars, and the great

 number

number of Ichneumon flies, we cannot conceive how it is possible that these insects should live several months under ground in a place so close and so impenetrable to the air if they needed to breathe in it. If indeed they were to breathe even the air which is inclosed along with them, so small a portion, passing so often through their spiracles, and being tainted with the exhalations it could not but receive from them, would be of no use to the insect.

Neither would I maintain the respiration of chrysalids; at least one experiment convinces me that there are some which do not always breathe. I took the chrysalis of the *Sphinx Ligustri*, which being one of the greatest is the most proper for experiments. It had, besides, the two anterior stigmata so open that with a common magnifier I could see into the substance of its body and observe a small vacuum between it and the cover. This made me hope that if respiration took place in chrysalids, this would give me certain proofs of it. Two or three months before the perfect insect issued from its cover, I dug it up, and covered, several times; first one, and then two, and afterwards successively the whole of its stigmata, with soap-water. At each time I observed for a considerable space, with the glass, the stigmata, thus covered, to see if any bubble of air was formed above; which would naturally have happened, had these stigmata served as conduits to the air in respiration; but with all my attention I could perceive none. Some days afterwards, I repeated the same experiment in a manner which appeared to me still more decisive. Instead of covering the stigmata with soap-water, I covered each with a little bubble of air, taken from the froth of the same water, that the air might enter and go out more freely. But my curiosity was not the more gratified; these bubbles which ought to have risen or sunk at each expiration or inspiration of the Chrysalis preserved constantly the same appearance, till, their pellicle becoming dry, they burst.

When the perfect insect had issued from this chrysalis I took it up instantly. I washed the inside of it, and observed at the stigmata of its segments little bundles composed of a great number of very white threads of which the longest were about two lines in length. These appeared to me the exuviæ of the pulmonary organs. I blowed on each of the stigmata with all my force, by means of a very slender tube, but my utmost efforts could neither swell nor move

any

any of thoſe fragments of the veſſels, which were attached to them internally; but this muſt neceſſarily have happened, had the communication of the external air by theſe ſtigmata in the bronchiæ remained open, or had the inſect, when incloſed in its chryſalis, been able to breathe through them.

If the reader is unwilling to draw a more general concluſion from theſe laſt experiments, it may at leaſt, I think, be inferred from them, that the chryſalis of the ſphinx liguſtri lives for ſome time without reſpiration, and that its two anterior open ſtigmata ſerve only to facilitate the evaporation of the ſuperabundant humours, and to permit the external air to ſupply their place.

PAGE 55, l. 15.

It is not to be doubted. It is not on the ſingle experiment here related, that our knowledge of the reſpiration of inſects is founded. That experiment does not appear to me ſo deciſive, as ſome may perhaps imagine. Even though an inſect ſhould not reſpire naturally, it might happen, if its parts are tender, and not apt to ſtretch, that, when placed in an exhauſted receiver, it would be killed. It would be ſufficient for this purpoſe, that the air, which is diſperſed in different parts of its body, ſhould be there confined, in ſuch a manner as to have no convenient iſſue. Thus, as ſoon as the air which ſurrounds the animal, and preſſes on it in all directions, is removed, the air within its body will not fail, in conſequence of its natural elaſticity, to dilate itſelf exceedingly, and thus to burſt the membranes and veſſels which keep it confined; this would certainly occaſion the death of the animal, though the want of reſpiration had no ſhare in it. We have proofs leſs doubtful of the reſpiration of inſects. The fact appears to me ſufficiently demonſtrated, with reſpect to many ſpecies of aquatic inſects: I ſpeak of thoſe which are often ſeen thruſting the extremity of their abdomen to the ſurface of the water, and remaining there, as if ſuſpended. Theſe extremities are with them the organs of reſpiration, and they keep them thus in the air, for the purpoſe of breathing. To be certain of this, we need only cover the ſurface of the water where they are, with ſomething which may prevent them from thus bringing their tail to the ſurface. They will immediately be ſeen greatly agitated, and ſeeking with extreme inquietude, ſome opening

opening through which to push it. If they find no opening, they are seen soon afterwards, to fall to the bottom and die, often in much less time than would be necessary to drown the most delicate terrestrial insect: an evident proof of the respiration of these animals, and that it is absolutely necessary to their existence. It is proper, however, to inform those who would make this experiment, that all aquatic insects, which respire at the posterior part of the body, do not die equally soon when deprived of the air. The dytisci can resist this proof for a long time; but their larvæ can support it but for a few minutes.

As to lungs, it is easy to assure ourselves that insects have them, even without the trouble of dissection; we need only examine, in the water, the greater part of their exuviæ, where we shall see floating, great quantities of white vessels, which are connected, by their principal trunks, with what was the orifice of the organs of respiration. These vessels are the fragments of the lungs. These lungs, in insects, divide into such an infinite number of bronchiæ dispersed over their whole body, that all the parts are, as it were, embarrassed with them, and it is often difficult, when we dissect an insect, to lay aside all those filaments, which confound by their number, every thing that appears. After this, would we not be surprised to learn, that these pulmonary vessels are not tubes composed of a single membrane; but vessels always open, composed of a cord or thread, the turns of which are like those of a spring wound round a cylinder, and which thus form hollow cylinders, which open a passage to the air? But this is not the only wonderful circumstance in the mechanism of these lungs. M de Reaumur found, that the strings which form them, have, in some insects, six raised sides, so that they seem to be composed of six threads, nearly cylindrical, fastened to one another. Who would have imagined, that such small vessels were constructed with so much art?

Page 55, l. 24.

It is found at the mouth. It is seldom at the mouth or at the head, that the respiratory organs of insects are to be found: nay, perhaps, there is not a single instance of their being situated in that place. As it is on the authority of Frisch that the author advances this fact, I think myself obliged to observe, that the experiment which induced Frisch to believe, that the aquatic larvæ of the smaller dra-

gon-flies

gon-flies respire by the under part of the mouth, is by no means decisive. These animals have the mouth, and all the under part of the head covered with a mask, attached to a kind of arm, which, issuing from the under side of the thorax, and making a bend, is folded back, and touches the animal under the chin. It is by means of this arm, if I may call it so, that the animal puts on, or takes off the mask from its mouth at pleasure. When this larva is seized between two fingers, even when it is dead, and its abdomen a little pressed, it is surprising to see it often raise its muzzle, project the angle of the arm from under the thorax, lower its mask, and, when the pressure is removed, put it on again. Frisch, who, like me, had made the experiment, draws from it a consequence which I cannot approve. He affirms, that this mask, and the arm by which it is attached to the chin, is the organ by which the animal respires, and the motion made by this arm when the abdomen of the larvæ is pressed, is a proof of this; because, according to him, the motion shews, that the air is communicated from the abdomen to the arm by the chin. But I am afraid, he is deceived in the conclusion which he thus draws. It is my opinion, that these animals, while they continue in the state of larvæ, respire water and not air; and that they inspire the water, not by the mask, but by their posterior part, through which also they discharge it. The expiration is more visible than the inspiration, but it is easy to convince one's self, that both are performed by the posterior extremity. Let a silk thread, such as is spun by the silk worm, be taken, and its extremity rolled up between the fingers into a little clew. This clew, when moistened, sinks to the bottom, and being suspended by so slender a thread, it receives all the motions which the larva communicates to the water. Let it be brought near to the orifice at the posterior part of the animal, and it will be seen, that the clew is alternately repelled and attracted, so as to shew distinctly, that its return to the body of the animal, is the effect of an actual attraction, as it is much more quick than it would be, were it the effect, merely of its own weight. These insects, therefore, respire by their posterior extremity, and it is water, and not air which they respire. Thus, when their abdomen is pressed under water, they are made to lower the mask: but no bubble of air issues, any more than it does from the other extremity; and we never see that these animals

nimals mount to the surface of the water to take in air; which many aquatic insects do which respire air. Besides, the action of lowering the mask, which they often do when their abdomen is pressed, by no means proves that they respire by that organ. On the contrary, it shews, that the fluid, which at that time is very visibly accumulated in a part of the arm, towards the inside of the angle, has no exit, as the turgescency lasts as long as the pressure is continued; and this may be reiterated at pleasure, even in a dead animal, which would not happen, did the fluid escape by that way. The mask has another use, much more certain; it is cleft in the same direction with the mouth, and re-cleft by another fissure, which falls perpendicularly on the first from the front of the muzzle. Upon the approach of an animal suited to their taste, these insects instantaneously lower the mask, and opening the clefts, they lay hold of their prey, and keep it inclosed and firm between these clefts, while they devour it at their leisure. The principal organs, which are to serve the purposes of respiration, when they are to breathe air, after they are changed into dragon-flies, instead of water which they breathe at this time, have their origin or openings on the thorax, where they are distinguished by two stigmata, and in these terminate all the pulmonary vessels which already contain air, even while the insect still lives in the water. It is difficult to say how the air gets into these; for, as was said before, the animal is never seen coming to the surface of the water to receive it. But that they do contain air is a certain fact, of which it is easy to be satisfied. We have only to put the water, which contains a few of these animals, over a gentle fire, and when it begins to grow warm, we shall see the air within them expand and escape in bubbles, sometimes with noise, by the two stigmata of the thorax. These remarks, I think, shew sufficiently, that dragon-flies, at least those of the species I am speaking of, before their transformation, respire by the hinder part, and afterwards by the thorax, and that therefore, the organs of their respiration, are by no means placed near the mouth in them, more than in any other insect that I know.

Page 55, l. 25.

At the extremity of their body, towards the tail. It is not only at the extremity of the abdomen, and at the thorax, that

that insects respire, great numbers respire by the sides. The orifices, by which they receive the external air, vary in number, according to the different species: they are generally from two to eighteen. The orifice is generally marked on the skin of the animal, by a little scaly plate, open in the middle, and furnished with membranes or threads, to prevent the ingress of improper substances. These plates are called stigmata, for want of a better name.

*This is what I have observed in the long and slender water bugs. These have at the extremity, a tail as long as their whole body. This cannot be the tube by which their eggs are deposited; for the males have it, as well as the females. Besides, it is evidently the organ of respiration, for after they have been sometime under water, they suddenly rise to the surface, and thrusting out their tail, take in the air, which they repeat as often as they have occasion.

Frisch likewise observed something similar in an aquatic larva, which changes into a fly, (the Musca chamælion.) This animal has two apertures at the tail, which resemble two nostrils, by which it breathes.

PAGE 55, l. 29.

**Air too thick.* This is observable in the great water beetle, dytiscus. It lives in the water, but the air which it finds there, is not sufficient for it, but it is obliged to raise the extremity of its body out of the water, for the purpose of respiration. "The observation," says Lyonet, "with "regard to this beetle, is common to a great number of "water beetles." We may add, probably to them all.

PAGE 55, l. *penult.*

**Insects can live without air for four-and-twenty hours.*— We know, that, upon pouring water on pepper, a great number of animalcules are discovered in the liquor. Derham relates, that he put a quantity of these into an exhausted receiver, for four-and twenty hours. He exposed them afterwards to the air for a day or two, when he found that some of them were dead, and others still alive.

PAGE 56, l. 7.

Or of lethargy. It is certain, that, among those insects which outlive the winter, there are many that pass it without much motion; but this rest does not become lethargic,

except in conſequence of extreme cold. A moderate froſt does not prevent them from moving, when they are touched; their heart or great artery, ſtill continues to beat; but it beats much more ſlowly than in ſummer. It is therefore to be preſumed, that they likewiſe breathe in winter, but at longer intervals than in other ſeaſons. All inſects, however, do not paſs the winter in ſuch repoſe; there are ſome, for which that ſeaſon is a ſeaſon of activity. I know many which move, eat, and grow, at that time, and do not undergo their changes till the ſpring. Inſects of this kind, it is obvious, muſt reſpire in winter, that being their proper ſeaſon.

Page 57, l. 14.

Couple with the females. See on this head, p. 290, in the rmarks on the words, *They multiply by generation.*

Page 57, l. 26.

**The moſt common figures.* The eggs of ſpiders, and many butterflies, are round. Theſe eggs, though round, are however, diſtinguiſhed by a variety of appearance. They are not all ſmooth, but ſome of them carved in many different ways, as may be ſeen in thoſe of many phalænæ. The eggs of many beetles are oval, and thoſe of the Chryſomela aſparagi are of a conical form.

Page 58, l. 8.

**The matter of theſe eggs.* The greater part of inſects are oviparous. I ſay the greater part, becauſe ſome ſpecies are viviparous, ſuch as the aphides.—*Author.* The aphides, or at leaſt many ſpecies of them, are both oviparous and viviparous. An aphis, that, during ſummer, has brought forth live young, lays eggs at the approach of winter, and theſe eggs are not hatched, till the following ſpring. *Lyonet.*

Page 59, l. 3.

**A great number of eggs.* There are ſome inſects, however, which lay but few eggs: the dor-beetle (Scarabæus ſtercorarius) lays but one: the Caſſida nebuloſa, only ſix or ſeven. Friſch.

The author's aſſertions in this note are not accurate. He refers to Friſch as his authority, who ſays only, that the Scarabæus lays but one egg in one hole; and that the eggs of

of the Caſſida, which he found on the under ſide of the leaf of an Atriplex, were in patches of ſix or ſeven together.

PAGE 59, l. 4.

Some hundreds. And even ſome thouſands; as for example, the mother or queen bee.

PAGE 60, l. 3.

Which afterwards becomes the inſect. If we believe Swammerdam, this obſcure point is by no means the inſect itſelf, but only its head, which firſt acquires its conſiſtence and colour.

PAGE 60, l. 7.

As in a matrix. Would it not be more natural, to compare this pellicle to the *chorion* and *amnion*, which encloſe the fœtus, than to a matrix?

PAGE 60, l. 15.

Till having become larger. Swammerdam likewiſe maintains, that the inſect does not increaſe in the egg; but, that its parts are there merely formed, and acquire conſiſtence.

PAGE 60, l. 18.

The little care. It is true, that moſt inſects ſeem to be no otherwiſe concerned for their eggs, than to depoſite them in places, where the young when hatched, may find a ſufficient quantity of the food that is proper for them. And this, indeed, is all the care that is neceſſary for theſe eggs, or which, for the moſt part, the mothers can take of them, as many female inſects die immediately, after having excluded their eggs. This care, however, does not always ſtop there; for it is often accompanied with other precautions. Many encloſe their eggs in a very cloſe ſilken web, others cover them with a coat of hairs, torn from their own bodies. Some ſpecies glue them together, with a maſs of viſcid liquor, which hardening in the air, ſecures them from injuries. Some make oblique inciſions in a leaf, and hide an egg in each of theſe inciſions. We find ſome placing their eggs within the bark of trees, and in places where they are entirely protected from the rain, from wind, and from the too great heat of the ſun. Some have the art of opening the nerves of leaves, and there laying their eggs, in ſuch a manner, that

an excrefcence is formed round them, which ferves at once for a fhelter, and for food to the young infect. Some envelope their eggs with a foft fubftance, which forms the firft aliment of the young, before they are able to ufe more folid food, and to procure it. Laftly, others make a hole in the earth, and after having carried thither a fufficient quantity of proper food, depofite their eggs. But, if a great number of infects, after having thus laid their eggs in convenient places, and ufed the precautions I have mentioned, abandon them to Providence, there are fome that never leave them at all. Such, for example, are fome fpecies of fpiders, that never move a ftep, without carrying along with them, in a kind of bag, all the eggs they have produced. Their attachment to thefe eggs is fo great, that they expofe themfelves to the greateft dangers, rather than quit them. Such, likewife, are bees, wafps, hornets, and many other forts of fimilar infects. It is well known, with what art they conftruct the cells for their eggs, and with what care they feed their young, till the time when they are ready to change into nymphs: thefe are facts known to every body, and on which it would be fuperfluous to enlarge. The care which ants take of their young, is carried ftill further. They are not contented with depofiting their eggs in places prepared for them on purpofe, and of feeding their young, till the time when they are to pafs into the nymph ftate; even then they continue to take moft wonderful care of them. With what labour do they not tranfport them in fine weather, from the bottom of their abode to the furface of the ground, that they may receive the benign influence of the fun! With what attention do they not carry them back to the bottom of their dwellings, when that luminary retires, or when the air begins to grow cold! What diftrefs do they not teftify, when an accident hath difturbed their neft, and fcattered the nymphs! No danger can frighten them from the places where thefe nymphs are thrown. They feek them every where with anxiety, and every one is employed in collecting thofe which are found, and placing them under fome cover till their firft abode is repaired, whither they are immediately tranfported. Thefe different inftances are fufficient, I imagine, to fhew that all infects do not abandon their eggs to chance; that there are fome, which take as great, if not greater care of their young, than many of the larger animals, and that even thofe that do abandon

bandon their eggs, never do ſo, till after having ſufficiently provided for their preſervation, and for the ſuſtenance of the young to be excluded from them. This, indeed, the author does not pretend to deny, as appears from the 13th chapter, which treats of the parental care which inſects have of their eggs and young.

PAGE 60, l. *laſt.*

Without the aſſiſtance of their parents. It would be a ſingular circumſtance, if Nature had devolved on inſects, the care of hatching the eggs of fiſhes. This, however, is an opinion adopted by M. des Landes, with regard to the eggs of the ſole, as appears by the Hiſtory of the Royal Academy of Sciences for 1722, p. m. 27. It is generally believed, on the coaſts of France and England, that ſoles are produced from a ſpecies of ſmall ſea-crab, named chevrette or crevette. M. des Landes cauſed a conſiderable quantity of theſe to be fiſhed up, and put them into a veſſel of ſea water. In twelve or thirteen days, he found in it eight or ten ſmall ſoles. He repeated the experiment often, and always with the ſame ſucceſs. He afterwards put the ſoles alone, into a veſſel of ſea water, and though they depoſited their ſpawn, there appeared no young ſoles. He found beſides, that when the chevrettes were newly fiſhed up, ſeveral ſmall veſicles were found among their feet, unequal in ſize and number, and firmly glued to their breaſt, by a viſcid liquor. Having examined theſe veſicles with a microſcope, he there ſaw a ſort of embrio, having the appearance of a ſole, whence he concludes, that the eggs of the ſole, in order to be hatched, muſt attach themſelves to the chevrette. I will not ſay, that the concluſion of M. des Landes is altogether without foundation; but I think he might have rendered his experiment much more deciſive, if, inſtead of the great quantity of chevrettes that he put into the veſſel, and among which there might eaſily have been mixed a few ſoles, without his perceiving them, he had contented himſelf with taking a few of the chevrettes loaded with the veſicles he mentions, and putting them ſingly into water. If he found, then, in the courſe of a few days, a ſmall ſole in the water, and at the ſame time, a veſicle leſs in thoſe attached to that particular chevrette, it would have been a proof, that the ſole was actually produced from that veſicle: But would this have been a proof, that the aſſiſtance of the chevrette

chevrette was indispensable to the exclusion of the sole from the egg? If the eggs of those that spawned in the vessel remained sterile, while the others produced young, the reason of the difference might have been, either that the males had not fertilised the spawn of the former, and that they had rendered fertile that containing the eggs attached to the chevrette; or perhaps, that these eggs, needing a degree of agitation to make them hatch, the first had not in the vessel, the necessary agitation which they would have received in the sea, while the chevrettes, by their motions, would have procured a sufficient agitation to the others.

Page 61. l 31.

This is so rapid. I should think it useless to observe, that the proverb here mentioned, exceedingly exaggerates the matter, if I did not know, that many people believe it literally true. It is, however, true, that of insects which are not remarkably minute, the generation of fleas, aphides, and other vermin of that sort, goes on with the greatest rapidity. As to larger insects, a whole year is necessary for their passing from one generation to another. The species which multiply twice a year, are in much smaller numbers, as are those which need more than a year to produce their like.

Page 62, l. 2.

It is allowed, that insects, &c. This is not an universal opinion. The surest way is, not to decide on a subject we cannot know. When we take a general view of the operations of insects, the great uniformity, which at once appears in the economy of each species, would make us believe, that they act merely by instinct. But, when we examine their proceedings in detail, and when we see, that they not only vary their operations, according to the necessity of the case; but that, when they are placed in difficult circumstances, in which, according to the ordinary course of things, they should not naturally find themselves, we observe, they do not fail to make the most of their resources, and that they can, with much industry, remedy accidents, and extricate themselves from very embarrassing situations, we are then tempted to allow them a portion of reason.

Page

PAGE 63, l. 13.

It is merely the external form. Although the changes which the external parts of insects undergo, in their different transformations, are the most remarkable, they are not confined to these parts alone. Very considerable changes likewise take place in their internal parts, some of which are elongated, others contracted; some lose their functions, others acquire new ones, and others entirely disappear.

PAGE 64, l. 7.

Into four different classes. The explanation of the four sorts of changes mentioned in this chapter, is taken from Swammerdam, who expresses himself on the subject, nearly in the same way with our author. Those who are not perfectly versed in the different transformations of insects, will perhaps be at a loss to comprehend what is here related. I shall endeavour, in a few words, to give as distinct an idea of them as possible.

For this purpose, it is necessary, in the first place, to know, what is properly meant by the state of nymph and chrysalis, so often mentioned. By these terms is meant, a state of imperfection, attended sometimes with inactivity, inaction, abstinence and weakness, through which the insect passes, after having attained a certain bulk, and in which its body receives the preparatives necessary for its passing to a state of perfection. All the external parts of the insect are then found enveloped, either with their natural skin, or with a fine membrane, or with a hard and crustaceous coat. In the first case, the limbs of the insect remain free, it preserves its power of acting, it eats, and its form is little different from what it was before. In the second case, the limbs of the insect are folded over its breast, but separate; it can neither eat, nor act, it retains hardly any traces of its former figure, and has only a confused resemblance to that which it is going to assume. In the third case, the cover brings all these parts of the animal into one mass; it makes it equally incapable of eating and acting; it has no resemblance, either to what it formerly was, nor to what it is to be. These three sorts of change, are evidently very different, and yet, we have but two words in our language to distinguish them by. We say of the insects in the two first cases, that they are changed into nymphs, and of those in the

the last case, that they have assumed the form of chrysalids. To these terms, it would be proper to add a third, in order to mark the difference between the first and second cases. It might be done, I think, very conveniently, by allowing the last to retain the name of nymph, and calling those of the first kind semi-nymph, or demi-nymph; a name which, perhaps, would not be inapplicable to them, considering the small degree of change they have undergone. Grasshoppers, which, instead of the long wings they acquire, have still only on their backs, the small cases, in which these wings are formed, are nymphs of this kind; they may properly be called semi-nymphs. Those who have had an opportunity of examining a bee-hive, cannot fail to have remarked bees, still imperfect in the shut cells; these are nymphs of the second order. The silk-worm furnishes a well-known example of insects under the form of a chrysalis.

Insects, which undergo no other metamorphosis, than that which has converted them from the soft substance of an egg, to a well-formed and living body, are those which constitute the first class of transformations spoken of in this chapter. They increase in size; the greater part cast their skin; some of their parts acquire a greater size than the rest, and sometimes take a different colour from what they had before. This is almost the whole change which these undergo.

The transformations of the insects of the other three classes do not terminate here: after having cast off their skins, for the most part several times, and after having acquired their destined bulk, all become either semi-nymphs, nymphs, or chrysalids. They pass a certain time under this form, and upon quitting it, assume that of a perfect insect, capable of generation. It is from the diversity which takes place in these three sorts of changes, that the principal characters, which distinguish the insects of the second, from those of the first and third class are taken.

The insects of the second class, are those that pass thro' the state which I have called the state of semi-nymph. They do not undergo a transformation which is entirely compleat, but in their last change, they have generally still all the members they had before, without having acquired any others, except they have got wings: and as we have already remarked, the semi-nymph differs little in form

form, from the animal which produced it. What always distinguishes it most, is, that there is seen upon its back, at the base of the thorax, the cases in which the wings are formed, which before that, appeared but little, and often not at all. In other respects, it walks, runs, leaps and swims, as before. The difference between the semi-nymph, and the winged insect which it produces, is not always so obscure. In some species, it is even so great, that it is with difficulty we can discover a trace of its first form; but this is not general, and the greater part, in their last state, differ in no other material part from the nymph, but in the wings.

The insects of the other two classes, do not enjoy the same advantage with the other. They lose the use of all their members when they enter upon their transformation, and have no resemblance to what they were before. An animal of these two classes, which before had no legs, or had five, six, seven, eight, nine, ten, or eleven pairs of legs, has now no more nor less than three pairs, which, with the wings and antennæ, are folded under its breast, and there remain immoveable.

What distinguishes these two last classes from each other, is, that the insects of the third class quit their skin, when they change into nymphs, or into chrysalids, and that those of the fourth change into nymphs under their skin, which hardens round them, and serves them then for a case.

These are the principal differences which Swammerdam and the author find in these four classes. They consist, to express it in two words, in this, that the insects of the first class, after issuing from the egg, undergo no other transformation: that those of the second suffer an incompleat change, and become semi-nymphs, before arriving at their ultimate form: that those of the third and fourth classes, before arriving at their perfect state, become, the first nymphs or chrysalids, and the others nymphs, by a total change of form, but with this difference, that those of the third class quit their skin at becoming nymphs or chrysalids; and that those of the fourth become nymphs without quitting their skin.

M. de Reaumur, to whom Natural History is indebted for so many beautiful discoveries, found, in the transformation of insects of the fourth class, a new character, which no one, perhaps, had observed before, and which, I think, distinguishes them more essentially from those of the other

classes, than the changing into nymphs, without quitting their skin. He discovered, that they undergo one transformation more than other insects: that before becoming nymphs, they assume under their skin, an elliptical form, or that of an elongated spheroid, in which no part of the animal is discernible; that in this state, the head, the thorax, the wings and legs of the nymph are inclosed in the interior cavity of the abdomen, from which they issue successively, by the anterior part, nearly in the same way as the extremity of the finger of a glove, which has been drawn in, is pushed out again. Thus, the insects of this class, are not solely distinguished from others, by their changing into nymphs under their skin: but principally, in that before becoming nymphs, they undergo a double transformation. According to this idea, the differences of the four orders of transformations may be reduced to terms simpler and more easily comprehended, by saying, that insects of the first order, after issuing from the egg, attain their perfect state, without being previously disposed to it, by a change of form; that those of the second class are prepared for it, by an incompleat change of form; and those of the fourth, by a double change of form.

* Lyonet here gives examples of these four classes of transformations. The first is exemplified by the common earth-worm. The second class, by a dragon-fly, (Libellula puella.) The third, by insects of the three different orders: 1. A pseudo-caterpillar, which feeds on the willow, with two and twenty feet, (Tenthredo marginata.) 2. A water-beetle of the largest size, (Dytiscus piceus.) And 3. A caterpillar with sixteen feet, which lives on the trunks of willows, oaks, &c. (Phalæna Cossus.) The fourth class is illustrated by a white maggot, which proceeds from the eggs deposited by the large blue flies in flesh, when it is about to turn putrid. (Musca vomitoria.)

The celebrated Bergman, before he betook himself to the illustration of mineralogy, had been fond of the study of insects, and he has left us a classification of larvæ, a concise view of which, it is hoped, it will not be improper to give in this place.

The metamorphosis of larvæ, says Bergman, consists in the excoriation, or deposition of the external skin of the insect, joined with a change of form. This, in general, is twofold, to wit, from the larva to the pupa, and from that, to

to the perfect insect. An insect, subject to metamorphosis is called a larva, as long as it continues under the form it assumed, when it first came from the egg, though many of them, during that time, cast their skin. It is called pupa, under the new form which it acquires, when it has thrown off the appearance of a larva.

Pupæ are either chrysalids, nymphs, or semi-nymphs. A hard, motionless pupa, that does not eat and shews obscurely the members of the future insect, is called a chrysalis. The nymph is a tender pupa, lying at rest, not eating, and which shews clearly the separate members of the future insect. But the semi-nymph is a running pupa, that eats, and is hardly different from the larva, except in having the vaginæ of the wings, which the larva wants.

The chief differences of larvæ lye in the feet, and in the head. As to the feet, some larvæ want them altogether, others have them, differing in number and figure. We are not accustomed to see animals with heads that undergo changes in the form; but this wonderful faculty is shewn by entomology. For many larvæ have a membranaceous head, that often changes its shape.

Larvæ may be divided into eight classes, one of these, (the Midæ) have a membranaceous head, all the rest have it hard or horny. The first class is called *Bracti*. The larvæ that belong to this class, have membranaceous and horny feet, of the former, always more than ten, of the latter, six. All these change into nymphs, and afterwards become Tenthredos. The second class comprehends the *Campæ*. Their character is, to have never more than ten membranaceous feet, furnished with hooks, and six horny feet. These change into chrysalids, and then become Lepidopteræ.

Simulta is the name of the third class. These larvæ have six horny feet, no membranaceous ones: the mouth furnished with teeth. These change into chrysalids, nymphs or semi-nymphs, and at last, belong to the orders Coleoptera, Neuroptera, or Aptera.

The fourth class is called *Ipedes*. Their character is six horny feet, and no membranaceous ones. Mouth without teeth, furnished with a single rostrum. The Ipedes turn into nymphs or semi-nymphs, and these into insects of the Hemiptera order.

The fifth class are the *Serphi*. They have six horny feet, and no membranaceous ones. Mouth without teeth, fur-

nished with two rigid rostrums. The Serphi first become nymphs, and then change into Dytisci or Hemerobii.

The sixth class, called *Bugones*, consists of such larvæ as have a round horny head, furnished with teeth sticking out; no feet. Those change into nymphs, and afterwards become insects of the Hymenoptera order.

The seventh class, *Raucæ*, have the head horny, and therefore unchangeable in its figure, but without exserted teeth. No horny feet. The Raucæ change into chrysalids or nymphs, and these into insects of the Diptera order.

The eighth and last class is called *Midæ*. The larvæ have a small membranaceous head, capable of changing its figure. Feet membranaceous, or none. All the Midæ pass through the state of nymph, into the order of Diptera, as far as is yet known.

PAGE 64, l. 15.

Fleas, Onisci, &c. If we may believe Leuenhoeck, fleas, at issuing from the egg, are worms which change into nymphs before assuming the form under which we know them; if this is so, they belong to the third class, and not to the first.

The onisci are viviparous, and suffer no transformation, consequently they belong to none of the four classes. If any of them are oviparous as some have affirmed, they may here find a place.

PAGE 64, l. 26.

Ants. Ants do not belong to the second, but to the third class: accordingly Swammerdam places them there in his HIST. GEN. P. 179. It is probable that Mr Lesser has classed them thus by an oversight, for Swammerdam, at P. 176, which the author quotes, explains the second order of transformations by the example of dragon flies, and not by that of ants.

PAGE 64, l. 27.

Aquatic flies. All aquatic flies do not belong to the second class. Many species of them belong to the third as the different sorts of Phryganeas; and many to the fourth, as all the *Asili*.

PAGE

PAGE 65, l. 7.

This is the metamorphosis which flies and Ichneumons undergo. That is, the greater part of flies with two wings. I do not recollect of ever having observed any with four wings which belonged to this class.

The Germans give the name of bastard wasps to those insects which the French call Ichneumons. I have observed the transformations of many species of these, but I never saw one that could be referred to the fourth class as it is here described. Swammerdam to make this class, it would seem, more numerous, has comprehended in it many insects which properly belong to the third, and hence has arisen the error of the author.

PAGE 65, l. 14.

Even six times. There are insects which change their skins still oftener. I know one caterpillar which does not become a chrysalis till it has cast its skin eight times; and another which changes its skin nine times.

PAGE 66, l. 5.

* Madame Merian relates of a caterpillar that feeds on the lime tree, that its chrysalis was as hard as a piece of wood, and that no force could bend it. P. 11. n. 24. p. 47; but of the truth of this I am in doubt.

The hardness of this chrysalis is a sign that it was dead and dried. When the animals are alive, they are never so stiff and hard. Madame Merian seems to have been afterwards convinced of this; for my Latin Edition which mentions the same caterterpillar takes no notice of this singular circumstance.

PAGE 66, l. 14.

The appearance of a child in swaddling clothes. All these representations are very imperfect, and require the assistance of fancy to find them out. The most remarkable that I know is that of the chrysalis of the Papilio polychloros. There is actually on its back some resemblance to a face; but what really deserves attention in these chrysalids is, that when we know in what manner the parts of the insect are arranged in them, it is not difficult to trace the head, the eyes, the antennæ, the proboscis, the thorax, the legs and the abdomen. In nymphs

nymphs all theſe parts appear more diſtinctly, and in thoſe I have called Semi-nymphs they are viſible at firſt ſight.

PAGE 66, l. 23.

* *Or producing the leaſt confuſion.* This is obſervable in the nymph of the Chryſomela Aſparagi. Its antennæ deſcend along its ſhoulders: its four firſt legs are laid upon its breaſt; the other two paſſing between the wings, join towards the tail, and the wings themſelves are applied cloſe to the abdomen.

This diſpoſition of the members, is very common in the nymphs of all coleopterous inſects.

PAGE 66, l. 24.

* *Externally all the limbs.* Thus in the nymph of the Scarabœus fimetarius we diſcover all the limbs of the future inſect. The Author.

This is ſeen with the ſame facility in the nymphs of all beetles, Tenthredos, Ichneumons and ſeveral other ſorts of flies. Lyonet.

PAGE 66, l. 29.

The colour of chryſalids. The cheſnut colour prevails in the cone-ſhaped chryſalids, but I have never obſerved it in the angulated ones.

Beſides the colours which the author enumerates, nothing is more common than to find a ſort of gilding on the angulated chryſalids. I have even ſeen ſome that were all over ſo brilliant, that at firſt ſight, one would have taken them for a piece of pure gold.

I do not know that any gilding has been diſcovered on the cone-ſhaped chryſalids; I have ſeen however a ſpecies of thoſe caterpillars called Geometræ, which may be ſaid to be gilded, but with a gold much darker than that of the angulated chryſalids.

This gilding does not appear at firſt on the chryſalids; it is only gradually aſſumed as they acquire by degrees their due conſiſtency. The Alchymiſts obſerving this production did not fail to draw from it a concluſion favourable to their hopes; but nothing could prove more fallacious; this gilding ſo beautiful and ſhining, has nothing of gold but its gliſtering. It owes all its ſplendor to the luſtrous white of the body of the animal, which ſhining through the yellow, tranſparent cover

cover of the chryſalis, produces an effect ſo wonderful. This M. Reaumur diſcovered, and he has given a very particular explanation of it in his firſt volume, Mem. X.

Page 67, l. 8.

A very gaudy one. To give an example of this; the female of the Phalæna antiqua is a very ugly, ill-ſhaped animal; but its chryſalis, for the regular diſtribution of the black and white marks with which it is generally adorned, is one of the moſt beautiful of any. On the other hand, the caterpillar Cloporte du Chene is one of the ugliest, and yet it produces a very elegant butterfly.

Page 67, l. 29.

Take the leaſt nouriſhment. Indeed it is perfectly impoſſible that they can take any, not only becauſe the animal in this ſtate is too weak to be active, but becauſe the ſkin, which envelopes the chryſalis, covers all the parts of the body, and confines them as in a caſe from which the inſect cannot extricate itſelf till the moment of its appearance in the perfect ſtate arrives.

Page 68, l. 12.

Thoſe which have not the ſame advantage. It is not always on account of the delicacy of their cover, that many inſects are careful to fabricate very thick cones which are often impenetrable to the air. There are ſome which are much harder and firmer than thoſe which remain ſuſpended in the open air, which laſt however make very ſolid cones. The reaſon of ſuch a diſſimilar method of preceeding ſeems to be that ſome nymphs and chryſalids require a ſlower and more inſenſible perſpiration than others, either for their developement in the proper ſeaſon, or for taking the form of a perfect inſect. What confirms me in this opinion is, that when I have taken thoſe nymphs and chryſalids which form thick cones out of their lurking places, I have always obſerved, either that they came forth ſooner than ordinary, or that the inſects which they produced were imperfect, or that they grew dry, and died without coming forth.

Page 68, l. 15.

* *A ſort of long wool.* The Germans call theſe inſects

wool-

wool-ſuckers, as we learn from Friſch: what the ſame author ſays of the Cochineal is very remarkable. The pores of its back are very cloſe, and there iſſue from them little ſhort hairs which cover the back in a ſhort time with a kind of coton; the abdomen which is defended by its ſituation, produces no ſuch hairs. If this coat is rubbed off, the inſect ſoon acquires another. The Auhor.

Obſerve that the inſect here mentioned is not the Cocheneal, but the Kermes. Lyonet.

Page 68, l. 21.

Outſide of their manſion. This is the practice of the inſect called by the Germans the Camel, becauſe it has two protuberances on its back. Reaumur and Linnæus call it the zic-zac, (Phalæna zic-zac) becauſe it commonly moves its body in a zig-zag direction.

Page 68, l. 30.

Repreſent an egg. There are likewiſe chryſalids of other figures, as the conical, the cylindrical, the angulated. There are ſome in the ſhape of a boat, of a turnip, of a drop or tear of glaſs, the body of which is ſwelled out, and the point incurvated. I have known ſome compoſed of two oval convex pieces, attached to each other by a plain ſurface, which is of equal breadth, and correſponds to the curvature of their outlines.

Page 69, l. 3.

The period of change into chryſalids is fixed. Theſe periods are not ſo conſtant but that a degree more or leſs of heat or cold will ſenſibly affect them. The ſame inſect which in the middle of ſummer ſhall have acquired its utmoſt ſize in leſs than three weeks, will need as many months, and even much more if it comes forth in the end of the ſeaſon. Such a nymph or chryſalis which in ſummer will change into a winged inſect in fifteen days, will employ ſometimes ſix, ſeven or eight months for the ſame purpoſe, merely for having gone into the chryſalis ſtate a few days later than thoſe which have changed ſo rapidly.

Theſe irregularities, cauſed by the occaſional prevalence of heat or cold, muſt not be conſidered as a diſorder in nature; they are an effect of the infinite wiſdom of the Creator, who by this means prevents inſects which live leſs or more

more than a year from coming forth in winter and thus perishing for want of food. This could not fail to happen were their life and their changes fixed to a number of stated days: whereas a degree more or less of cold being capable not only to retard their operations but even to suspend the whole effect of them for a very long time, they are thus prevented from coming forth at a time when they could not find food.

Page 69, l. 11.

Some a whole year. And even much longer. A caterpillar of a large size which feeds on the alder, and produces a Tenthredo, did not appear in its perfect state till two and twenty months after it had inclosed itself in its cone, altho' in order not to retard its transformation I kept it in a pretty warm place.

Page 69, l. 17.

Some have this remarkable property. It must not be supposed from this that the same winged insect issues twice a year from the chrysalis; this never happens: it is to be understood of those insects which breed twice a year.

Page 69, l. 23.

Plants and leaves. That is, such as have occasion for such substances. Many winged insects do not eat at all. Some species of this kind issue from their chrysalis at the end of Autumn, and even in the middle of winter.

Page 71, l. 21.

With knobs. These knobs are more remarkable than they appear to be. Perhaps I shall hardly be believed when I affirm that they are the male organs of generation. I am however certain of the fact, as I have more than once seen certain species of spiders use them in this way. The males of this genus have their body more slender and their limbs longer than the females. It is a laughable enough scene to see them making love. Both mounted on their web, approach each other with circumspection and measured step. They extend their legs, shake the web a little, and pat each other with their foot as if they durst not approach. After this contact, fear often seizes them, they let themselves fall with precipitation, and remain for some time suspended by

their thread. Afterwards they take courage again, ascend and pursue their former course. After having patted each other for a long time with equal distrust on both sides, they begin to draw nearer, and to become more familiar. Now the mutual patting becomes more frequent and bolder; all fear ceases, and at last from this introductory dalliance, the male finds himself in a condition to terminate the business. One of the knobs of his antennæ opens suddenly as if by a spring, and there appears a white body; the antenna folds itself under the belly of the female, and the white body attaches itself to that part a little lower than the breast, and performs the function for which nature hath destined it.

If we did not know that spiders hate one another so naturally that they never meet, except at the season of engendring, without killing one another, we could not but be surprized at the strange manner in which they make love: but when we are acquainted with the reason of their cautious behaviour nothing appears strange; and we cannot but admire their circumspection and care, not to deliver themselves up blindly to a passion, which if imprudently yielded to, might prove fatal to them. This is a lesson which they give the Reader.

Page 71. l. penult.

Those of the male are smaller, shorter, &c. As the antennæ of the male are generally larger than those of the female, it would not have been amiss had the author given us some instance of the contrary.

Page. 72. l. 3.

* *In some species the male only has wings.* This is the case with aphides. The author, on the authority of Frisch.

This is a circumstance which ought to be examined; for those who have studied the aphides have found that those with wings, as well as the others brought forth young. In the mean time other examples may be given of the author's assertion. The males of the glow-worm, those of two sorts of caterpillars with horns, those of several species of Geometræ have wings, but the females want them. Lyonet.

Page 72, l. 4.

* The female of the great black corn beetle, has only two small membranes instead of wings. The Author.

The female butterflies of some species of Geometræ have likewise very small ends of wings.

Page 72, l. 12.

A tube longer or shorter. I know some species of ichneumons whose tube is nearly two inches long. The large tail which some species of grasshoppers have, especially those of the larger size, and which the common people suppose to be the male organ, is really that of the female who makes use of it for laying her eggs in the earth.

Page 75, l. *first*.

Which would perish in fresh water. This is a singularity as remarkable as that mentioned by Swammerdam in his Biblia Naturæ; that the larva of the Asilus lives equally well in salt water as in fresh: it is not however without example among other animals. We know that the salmon and the shad come to fresh waters to deposit their spawn: and perches are found in sea-water; but what perhaps will appear unexampled, is the worm which M. Reaumur found could live four and twenty hours in spirit of wine.

To this observation of Reaumur's, though not immediately connected with the subject of the Note, we shall here take occasion to add a very singular instance of tenacity of life in a species of insect, the Tenebrio mortisagus Lin. made by Mr Henry Baker, and recorded in the Philosophical Transactions, Numb. 457. P. 441

" I chose one of the largest of these beetles, (says Mr Baker,) and threw it into a cup full of common lamp spirits, and in a few minutes it appeared to be quite dead. Whereupon I shut it up in a round pill-box of about an inch and half diameter, and carried it in my pocket next day to London, where I tossed it into a drawer, and thought no more of it for above two months after; when opening the box I found it, to my great surprize, alive and vigorous. Having however no intention of keeping it alive, I again plunged it into spirit of wine, and let it lie considerably longer than the first time, till supposing it dead beyond any possibility of recovery I put it into the box again, and locked it in my drawers without looking any more at it for a month at least, when I found it again alive. And now I began to imagine there must be somewhat extraordinary in this creature since it could survive the force of spirit of wine, which soon kills most other

other insects, and live for three months without getting any sustenance.

A few days before this, a friend had sent me three or four cock-roaches (Blatta orientalis) brought alive from the West Indies. These I had placed under a large glass of six or seven inches diameter, made on purpose to observe the transformation of caterpillars; and now I put my beetle amongst them, that he might enjoy a greater share of liberty than he had done for three months before. I fed them with green ginger, moistened in water, and they eat it greedily; but I could not find, nor do I believe that the beetle ever tasted it during the whole five weeks they lived under the glass together. Perceiving the Coch-roaches begin to decline in vigour, I was afraid they would lose much of their beauty, if I permitted them to die of sickness; wherefore I put them into spirit of wine, and the beetle their companion with them. They appeared dead in a few minutes, and I believe were really so; the beetle seemed likewise in the same condition; whereupon, after they had lain in spirits about an hour, I took them out, and whelmed the glass over them, till I should have leisure to dispose of them as I intended. This was about ten o'clock in the morning, and I saw them no more till evening, but found the beetle then creeping about as strong and vigorous as ever; and therefore I resolved to put him to a trial I imagined he could not possibly survive, which was to let him remain a whole night in spirits; but here too I found myself mistaken; for after he had been taken out a day, he appeared as lively as if nothing had happened to him.

Since that time I have put him no more in spirits, but have kept him under the glass afore-mentioned, where he is alive at present: though during the two years and half he has been in my possession, I have never been able to discover, that he has drank or eaten any thing. In the exhausted receiver, where I have kept him sometimes for half an hour, he seems perfectly unconcerned, walking about *in vacuo*, as briskly as in the open air; but upon admission of the air, he shrinks his legs together, and appears in a surprise for near a minute."

It is added in a Postscript, that this beetle (after being kept half a-year longer) was permitted to get away by the carelessness

carelessness of a servant, who took down the glass to wipe it.

PAGE 75, l. 3.

Cannot live but in fresh waters. There are found in the *Saltze*, a small rivulet near Nordhausen, brown insects with six legs, which live in cases hardly half an inch in length. These cases end in a point, and are not so gross as a straw: they seem to be constructed of all sorts of rubbish glued together, something like the nests of swallows. The Author.

There are many insects of this kind, and each species has its own particular way of fabricating their cases. Some construct them with an art and regularity that cannot be enough admired. Of this kind are all the different species of Phryganeas. Lyonet.

PAGE 75, l. 30.

Food to the animals of both elements. The insects which may be considered as amphibious, are not all so in the same way. There are some which after having been aquatic under one form, so change their nature upon quitting the water, that if they should afterwards fall into it, they would be drowned. Others grow, live and undergo their transformations in the water; after which they live in both elements. Some, after having been produced in the air, plunge into the water, and remain there till they acquire wings, when they become again inhabitants of the air. Many species are produced, and grow in the water, change into nymphs in the earth, and pass their perfect state in the water, and in the air, but chiefly in the former. Lastly there are some which pass their larva state under the water, without being aquatic except in the head; the rest of the body is never wet; it is always surrounded with a volume of air considerable enough to permit a free respiration. These insects after their last change live only in the air. What a diversity!

PAGE 75, l. 35.

Protection against the rigours of winter. All insects which retire into the earth are not induced to do so merely to avoid the cold. The greater part enter the earth in order to undergo their transformations there, and others to lay their eggs.

PAGE 76.

PAGE 76, l. 6.

Vaults under ground. Among the insects of this kind, perhaps the most singular, and at the same time the most noxious, are a sort of ants in the East Indies, (Termes fatale.) According to the accounts of creditable persons, these ants never walk above ground, but always make subterraneous galleries, leading to the places they wish to go to. When they are busy at this occupation, and meet with any solid body, which is not absolutely impenetrable, they pierce it through and through. They do more: for instance, in order to reach to the top of a post, they do not run along its external surface; they make a hole at the bottom; they enter into the heart of the post, and hollow it out, till they arrive at the top. When the matter through which they wish to go, is too hard for them, such as a wall, or a marble pavement, they proceed in another way. They make along the wall, or on the pavement, a vaulted road, composed of earth, cemented by means of a viscid liquor, to lead them to the place they intend to visit. The business is more difficult when they have to pass over a mass of detached substances. A road, arched only at top, would leave beneath, too many open spaces, and would form a course too rugged for them; accordingly, they provide against it, but with immense labour. They in this case construct a sort of tube, a conduit in the form of a canal, which allows them to pass over the mass, and covers them on all sides. A person, who assured me of the truth of all these circumstances, told me, he had himself seen these ants, which had penetrated into a store-house of the East India Company, on the floor of which was a heap of cloves, which reached to the cieling; they had made to themselves a hollow covered way, which conducted them above this heap, without touching it, to the second story, the roof of which they had penetrated, and destroyed in a few hours a rich cargo of India stuffs, which they had pierced through and through. Roads, of such laborious construction, would seem to require immense time from the ants which form them: but it costs them much less than one could easily believe. The regularity with which a vast multitude labour at the work, makes it go on rapidly. Two large ants, which apparently are females, though perhaps males, as the males and females are generally larger than the neuters, direct the

the work, and mark out the tract. They are followed by two files of operative ants, the one file bearing earth, the other a viscid liquor. Of these two files, the foremost ant of the one lays down his parcel of earth at the side of the vault or hollow of the road begun; the other moistens it, and both join in kneading it, and gluing it to the edge of the road. When this is done, these two retire, in order to collect more materials, and then take their station, at the rear of the two files. Those which are next them, after they have retired, deposite, in the same manner, their burden of earth, moisten it, attach it to the edge of the road, and retire likewise, to procure materials for continuing the work. The whole files do the same, and thus, many hundred ants are able to work in a very narrow space, without embarrassment, and carry on their operations with astonishing celerity.

PAGE 76, l. 18.

Larvæ in dunghills. The number of insects which live in dung, is very considerable. To be convinced of this, we need only, from time to time, examine the dung of cows, which is found in meadows; we shall there see a surprising number of different species of insects: it is a Peru for a naturalist not over delicate.

PAGE 76, l. 30.

To many species. Such are the oak and the willow, which nourish some hundreds of species. The dock, the beet, and the nettle, are likewise the favourite food of numbers of these animals.

PAGE 76, l. 32.

*At the root of the *Polygonum minus cocciferum*, (Scleranthus perennis,) are found little vesicles, which the common people call the blood of St. John, because when they are bruised about St. John's Day, there issues from them, a red liquor like blood. These vesicles are the production of a fly, which lays its eggs on the roots of the plant, and from them there come red larvæ, called cochineal worms. They suck the substance of the roots, and of the juice, which issues from the wound they make, there is formed a vesicle round the larva, in which it lives. See Frisch, P. V. n. 11. P. 7. 8. The author.

The insect here mentioned, is not the true cochineal; it is

is what is called the ſcarlet ſeed, or if you will, the Kermes polonicus. See Reaumur, Tom. IV. Part I. Mem. 11. Lyonet.

PAGE 78, l. 10.

Cauſe of an excreſcence. Theſe excreſcences are commonly named galls. There is a very great number of ſpecies of them, differing from one another in colour, form, ſize, and hardneſs. M. de Reaumur has given a very curious deſcription of ſeveral ſorts of theſe galls, and of the inſects they contain. See his Mem. 12. Tom. III. Part II.

PAGE 78, l. 24.

**They effect a lodgement in other animals.* I mention here, the places of animals, in which theſe inſects reſide, and not only the places where they are moſt commonly ſeen, but thoſe too, where it is rare to find them, that the reader may ſee, that they neſtle every where. I imagine, that thoſe which are found in the ſkin, proceed from eggs: That thoſe which lodge under the ſkin, are formed there from the eggs of ichneumons, and that thoſe which are found in the inteſtines, proceed from the eggs of inſects, which have been introduced into the body, in eating or drinking. The author.

It may happen, that among the inſects which are found in the inteſtines, ſome may have been introduced in eating or drinking; but there is reaſon to doubt, whether the greater part enter in this way. Thoſe which are moſt commonly found there, have no reſemblance to thoſe ſeen elſewhere, and there are ſome ſpecies which certainly do not enter the inteſtines by the mouth; ſuch are thoſe, which certain flies lay in the rectum of horſes, and which afterwards inſinuate themſelves higher up in the body. Lyonet.

PAGE 78, l. 27.

Of caterpillars and ſpiders. The number of ſpecies, in the genus of ichneumon is very great, and there is hardly an inſect, from the minute aphis, to the largeſt caterpillar, in which they do not lay their eggs: even thoſe which are incloſed in galls, and in the trunks of trees, are not ſecure from them. A vaſt number of various larvæ periſh in this way. It is, perhaps, one of the moſt efficacious means employed by Providence, to maintain an equilibrium in the multiplication

multiplication of insects. The examples, however, of ichneumons laying their eggs in the bodies of spiders must be very rare. I do not recollect, that any other author has mentioned it, and it has never occurred to my observation. The case, however, is not by any means impossible. Wasps eat spiders, and there are species of ichneumons, which carry to the holes where they lay their eggs, spiders and other insects, which they maim, to prevent their getting away, that they may serve for food to their young, when hatched. The only thing which appears difficult, is to conceive, how an ichneumon fly, so little as that the body of a spider shall be sufficient to afford it nourishment, till it undergoes its change, should be able, with impunity, to lay its eggs, in the body of an animal, so vicious as the spider.

PAGE 78, l. *penult.*

On Bees. I must observe, that in this work, the author does not always understand by the word *bee*, the insects that yield us honey; but all sorts of flies, which, in their external form and habit, resemble them. The German word *bienen*, here translated *bees*, has that extended signification.

PAGE 79, l. *first.*

Animals covered with a shell. The example of beetles may clear up this doubt. They are defended with a kind of shell, and yet those which have the hardest, are not secure from the attacks of vermin.

PAGE 80, l. 6.

A bird, called Taputa. Insolens in Taputa natura. Viva tota vermibus farcitur. Has pro carne habet; his singula membra imbuta; præter hos et pellem nihil carneum. Cutem non perforant, densis exornatam pennis. Nieremb. *Hist. Nat. Exot.* L. 10. c. 14. It is evident, there must be exaggeration in the account here given of the Taputa; for the existence of a living bird, whose internal parts should consist of worms instead of flesh, is absolutely impossible.

PAGE 80, l. 16.

**The gad-fly pierces the skin of cows.* These worms owe their existence to flies, which in the heat of summer, introduce their eggs under the skins of oxen. There they first form a knob, which increases in size, and suppurates;

 and

and when pressed, there issues from it, a worm of a dirty white colour. See the curious history of this worm, in Reaumur, Tom. IV. Part II. Mem. 12.

PAGE 81, l. 15.

To extract them from the nose, &c. Without denying, that the larvæ of insects are sometimes actually found in the nose, the eye-brows, and in other external parts of the human body, I cannot help remarking, that people are often deceived on this head, and what they take for worms, is nothing but hardened pus. When a pustule has suppurated, without the matter being expelled, it fixes there, and becomes of the consistence of paste. The pustule remains open, and the pus which fills it, appears at the orifice, like a brown spot, because the air has dried and hardened the top: it is this spot which is taken for the head of a worm, and must be got out: the pustule is pressed, and the pus, issuing from the orifice, takes a cylindrical form, which is supposed to be the worm coming out, head foremost. The pressure not being on all sides equal, this pus does not issue in equal quantity on every side, which gives it the appearance of twisting and contorting itself in various directions. Is not this enough to establish a popular notion? Merely to touch, however, this pretended worm, would sufficiently convince one, that it was by no means what it is commonly believed to be: but this is never thought of.

PAGE 82, l. 7.

Became a perfect fœtus. The opinion of Leewenhoek, and his followers, on the formation of the fœtus, appears to me, on one hand so little demonstrated, and on the other, subject to so many difficulties, that I think it reasonable to withold my assent to it, at least, till the proofs are more convincing. I see indeed, by the text, that some authors have opposed it. I have had no opportunity of consulting these; but, without having recourse to their reasoning, which might perhaps furnish me with arguments, stronger than those I have advanced, I shall content myself, with simply stating those which have occurred to me, in reading what Leewenhoek and Andri have written on the subject.

My remarks shall only be directed against the system of animalcules, without pretending to attack that of germs and

and developements, with which I have no business in this place, and which I leave to its own fate. Let us begin, by examining the ground on which the doctrine of animalcules rests: and they are the following. The two authors I have mentioned, affirm, that the spermatic animalcula are found, few or none at all in early youth, in decrepitude, in impotent people, in the excessively incontinent, in high fevers, or in disease. They maintain, that these animalcula are found always in people that are healthy, vigorous and potent, and in the matrix of females that have had connection with the male; whence they think they are entitled to infer, that fecundity resides in the spermatic animal, and that it is this very animal, which is converted into the fœtus. M. Andri thinks himself the more justified in this conclusion, that those of man have a head larger than those of other animals; as this corresponds to the figure of the human fœtus, the head of which is very large, in proportion to the rest, when this fœtus is still very small.

But not to multiply circumstances, I shall grant to these authors, that few or no spermatic animalcules are found in those cases, where they pretend they are so rare, or that they are wanting altogether; but I must be permitted to doubt the universality of the opposite fact, to wit, that they are always, and without exception, found in all animals capable of generation. A multitude of experiments are necessary, to establish such a fact, and the system of Leewenhoek would not perhaps gain much, if they were oftener repeated. It is said, that great and enlightened philosophers, who have wanted to verify these experiments, have not always found living animalcula in the semen of animals perfectly fit for generation; and without going further, Leewenhoek himself, has known many persons in health, of a proper age, and who even had families, and yet, who had no animalcula. Such experiments would make one doubt the validity of the system in question; but they do not puzzle its partizans. They have always two answers to give: *The experiments have not been properly made*; or, *the subject was impotent*.

Let us leave them this resource. Supposing it proved that fertile semen alone is full of these spermatic animalcula, what better reason have they to conclude that the animalcula are the cause of fertility, than I have to conclude that fertility produces the animalcula? May not the semen pro-

per for generation alone possess the quality necessary for making them multiply abundantly, while in sterile semen, which has not the same quality, they multiply so little that they are hardly discernible in it? A species of small serpent is often generated in vinegar, but never in the wine of which that vinegar is made; must we therefore conclude that it is the existence of these serpents in the liquor which makes it vinegar and not wine; or ought we not rather to conclude that they are found in vinegar only because it is fit for their living and multiplying in? Stagnant water nourishes a vast number of small animals which are not found in fresh water; shall we conclude that these animals have made the water stagnant, or that the stagnant water has multiplied the animals? But to give an instance more nearly connected with the present question: we know, that certain vermin, which it is indelicate to name, multiply exceedingly, in the bodies of such as are of a luxurious temperament, and but little in people of a more temperate constitution, and that it perishes in people afflicted with disease. What are we to infer from this? Will it be said, that it is the vermin which produces the luxurious temperament; or, that it is the temperament that has multiplied the vermin? I imagine, no body will hesitate, in adopting the last opinion; why then should we think differently with regard to the animalcula we are talking of?

Further, if animalcula were only found in the semen, and in the vessels which prepare it, this singularity might prepossess one in favour of the doctrine of Leewenhoek; but they are found of different sizes in all parts of the body. Leewenhoek himself discovered exceedingly minute ones, and of different kinds, under the skin, in the mass of blood, in the fœces, and even in the foulness of the teeth. These animalcules, surely were not destined for the multiplication of the individuals of the species on whom they lived; why must those of the spermatic fluid be so?

But, it is said, the spermatic animalcula are of a very different nature from those which live upon us. The first do not injure the health, and are never found, but in vigorous subjects. The others, on the contrary, are noxious, they bring on diseases; and it is often in disease that they multiply most.

Suppose these facts should be granted, I do not see that the system of Leewenhoek would gain much. But how is it known,

known, that the ſpermatic animalcula are not noxious, and that their exceſſive numbers do not generate diſorder in the humours, by which they themſelves may periſh? And though they ſhould not injure the health, need we ſeek any other reaſon for this, than their extreme minuteneſs? Animals, a million of times leſs than a grain of ſand, and which live in a fluid, do not ſeem calculated to produce much diſturbance in the bodies they inhabit; eſpecially, if we conſider, that the ſubſtance they feed on makes no part of thoſe bodies, but is ſeparated from them, to anſwer other purpoſes, ſo that theſe animals do not live at the expence of their hoſt. The caſe is not the ſame with thoſe animals which we know are hurtful; they feed on our ſubſtance, they conſume the chyle, they attack the nobler parts, and are large enough to produce numberleſs diſorders. Beſides, theſe animals are of many different ſpecies. If ſome are generated in diſeaſe, there are others, perhaps, which can only multiply on the ſound and healthy. Thoſe worms, which are ſometimes voided by ſick perſons, are no more a proof that they are generated by diſeaſe, than they are a proof, that diſeaſes kill them.

But how is it known, that all animals which live at our expence are hurtful to us? Are there any proofs, that thoſe exceedingly minute animalcula, which are found in the maſs of blood, and perhaps in the whole body, have ever done us the leaſt harm? Theſe are the animals, and not thoſe an hundred millions of times larger, which ought to be ſet in oppoſition to the ſpermatic animalcula, in order to draw a concluſion in favour of the latter.

What has been ſaid, in my opinion, ſufficiently ſhews, that even though fertile ſemen ſhould alone be always full of animalcula, it would by no means follow, that they are the cauſe of the fertility of that ſubſtance. As to the reſemblance, ſaid to be found between the human ſpermatic worm and the fœtus, the head in both being large in proportion to the reſt of the body, I do not ſee that any great advantage can be made of it. It is not a very concluſive argument to ſay, the animalcule has a large head, the fœtus has a large head, ergo, the animalcule makes the fœtus. From the way in which this animalcule is figured, neither its body nor its head, have any reſemblance, in external form, to the head and body of the fœtus. It rather reſembles a tadpole, conſiſting of nothing but a head and a tail,

tail. Mr Andri himſelf makes this compariſon. Now, as what is taken for the head of the tadpole, is in reality its whole body, incloſed in an orbicular ſpace; may not the ſame be the caſe with the ſpermatic worm, and then, what becomes of its reſemblance to the fœtus?

We conclude, from all this, that the ſyſtem of Leewenhoek is not built on any ſolid foundation: and that therefore, even though it ſhould not be attended with difficulties, we ought never to conſider it, but as a mere conjecture, which we may admit or reject, as we find convenient, and of which, a little more or leſs probability, makes all the merit.

But this ſyſtem is very far from being free of difficulties: many might be urged againſt it, of which the following are a few.

I remark, in the firſt place, that according to the obſervation of Swammerdam, there muſt be many ſorts of animals, even in thoſe, of which it is pretended ſpermatic animalcules are found, that by no means owe their origin to theſe worms. M. Leewenhoek maintains, that the ſemen of inſects is full of animalcules, as well as that of other animals. He has been able to diſcover them in that of beetles, dragon-flies, graſshoppers, gnats, and even in fleas; but Swammerdam, who is not uſed to advance facts on ſlight grounds, lays it down as certain, that the fœtus of inſects, from the very formation of the egg, and conſequently, long before copulation, fills the whole capacity of the egg. If this be true, it muſt follow, of neceſſity, that this fœtus does not derive its origin from one of the animacules in the male ſemen, which could not enter into the egg, till long after its formation. Here, then, is a fœtus formed, without the aſſiſtance of ſpermatic worms, and that, even in an animal which poſſeſſes them. Is any thing more needed to overturn the ſyſtem I am examining?

I obſerve, in the ſecond place, that Leewenhoek, in a letter, without date, written to Sir Chriſtopher Wren, and inſerted in the collection of his letters, printed in 1696, ſays poſitively, that he had found two ſorts of ſpermatic worms in the ſame ſubject, whence he concludes, that the one produces the male, and the other the female.

But, have we not better reaſon to conclude, that they produce neither? Indeed, if theſe animalcula differed from one another, only in ſex, is it probable that the difference would

would be ſo great, in animals of ſuch extreme minuteneſs, as to make them appear animals of two different ſpecies? And, if they really are animals of two different ſpecies at firſt, how can they afterwards become animals of the ſame ſpecies, differing only in ſex?

My third obſervation reſpects the origin of thoſe ſmall animals. They are not found, according to Leewenhoek, and thoſe who adopt his ſyſtem, in early youth; at the age of puberty, their number is prodigious; they almoſt all periſh in diſeaſe; they appear again, on the return of health, and the vaſt quantity,loſt at the union of the ſexes,is always ſupplied while the generative faculty remains. From all theſe facts, we cannot but conclude, that theſe animalcules are generated in the body which harbours them; and, if they are there generated, I demand how this takes place. Are they formed there, by an immediate production, or by way of propagation? If they are formed by an immediate production, we muſt allow, that there reſides in the ſeminal matter, or in the veſſels which form it, a faculty, capable of producing daily, hundreds of millions of living beings, without the aſſiſtance of any animalcule; and if ſo, why may it not be allowed, that the fœtus can be produced in the ſame manner, without the ſame aſſiſtance, by a ſimilar faculty? But, if it is maintained, that the animalcules in queſtion are multiplied in the ſpermatic fluid, by the way of propagation, they muſt not only be fit for generation, long before attaining the age of maturity, and in a ſtate, in which they could hardly be ſaid to have begun to be animals; but, according to the principles of Leewenhoek, we muſt alſo allow, that in their ſemen, there are other animals, infinitely ſmaller, to which they owe their origin, as theſe other animals muſt, in their turn,owe theirs to animalcules, ſmaller ſtill, in the ſame proportion, which might be carried *ad infinitum*, unleſs we ſhould find at laſt ſome, whoſe ſemen had the faculty of fecundating the female, without the aſſiſtance of ſmall animated pre-exiſting beings. And, if we muſt come to that at laſt, what do we gain by the ſyſtem of Leewenhoek? And, why not allow the ſame faculty to the ſemen of larger animals?

In the fourth place, if it is maintained, that the fœtus is formed of one of theſe ſmall ſpermatic animalcules, we muſt ſuppoſe it to grow, with ſuch ſurpriſing rapidity, as, if it is not altogether impoſſible, is at leaſt incredible, and has

no

no example, that I know of, among other animals. Let us ſuppoſe, that, in ten days after conception, the fœtus of a bitch has only attained the ſize of a pea: that a pea is equal to five hundred grains of ſand, and that a grain of ſand is a million of times larger than the ſeminal animal of the dog, as Leewenhoek himſelf affirms, in his letter of the 13th July, 1685, Edit. 1696; we ſhall find, by calculating on theſe data, that this fœtus has become, in ten days, five hundred millions of times larger than it was. Such an aſtoniſhing growth will appear the more ſingular, that there is here no unformed maſs of matter, increaſing by an external accretion of parts; but, that it is, according to the ſame author, an organized body, with a ſtomach, inteſtines, and other parts, which enter into the conformation of our body, and each of which, like it, grows by intus-ſuſception.

But, if the ſpermatic animals grow with ſuch celerity in the uterus, is it not, in the fifth place, very ſtrange, that they ſhould not grow in the ſemen, although they are there immerſed in their native ſubſtance, which nouriſhes them, and preſerves their life? By what miracle does it happen, that an animal, which, in the uterus, can become, in ten days, five hundred millions of times larger than it was, cannot grow in the ſemen, however long it may remain there. Does not a circumſtance, ſo incomprehenſible, lead one to believe, that the animalcule and the fœtus, are beings of a very different kind, and that the one, by no means proceeds from the other?

In the ſixth place, it appears ſtrange, that of ſo many hundred millions of animalcules, which, it is ſaid, enter at one time into the matrix of the larger terreſtrial animals, there ſhould be only one or two, or at moſt ſeven or eight, according to the ſpecies which become fœtuſes there. If the fœtus proceeded from the ſpermatic worm, we ſhould naturally expect to find in the matrix, ſome days after copulation, a vaſt number of fœtuſes. But we find no ſuch thing. All that are found, are merely the ſmall number of ſuch as are deſtined to become perfect animals. According to the idea of Leewenhoek, who denies the exiſtence of an ovarium, we cannot account for an event ſo little agreeable to nature, except, in ſuppoſing, that among thoſe myriads of animalcules, there are only a few that have received the faculty of exiſting, or, that in the uterus, there are but few places proper for receiving and foſtering thoſe little beings: we

muſt

must likewise suppose, that these places are exceedingly small, otherwise we must believe, that a single place would be sufficient for a great number, at least for a certain time. Those who imagine, that the fœtus of all animals proceeds from an egg, are likewise at a loss to extricate themselves from this difficulty. Some take it for granted, that after the egg is detached, as they pretend, from the ovarium, and has fallen into the matrix, there is a very narrow aperture in it, at the place by which it adhered to the ovarium; that this aperture is shut by a valve, which permits the entrance of the spermatic worms: that these worms, by a natural instinct, endeavour to enter by the aperture; that, when one has got in, its tail presses upon the valve, and shuts the entrance against the rest, and, that this is the reason, why there is only a single fœtus in each egg, and that such a multitude of animalcula produce so few fœtuses. But all this requires another supposition, contrary to experience, namely, that the egg, which, they say, has fallen into the matrix, must be so small, that a worm, a million of times less than a grain of sand, cannot extend itself in it, its whole length; for, without supposing this, its tail could not press against the valve, and keep it shut. Now, it is very certain, that these bodies, which are taken for the eggs of the ovarium, are of a very discernible bulk, and infinitely exceed that of the animalcula in question. Others pretend, that the semen rises in vapour in the matrix, and that this vapour, being loaded with animalcules, penetrates to the ovarium, through the Fallopean tube: that at this time, the pores of the eggs ready for fecundation, are so open, that they permit the entrance of the animalcules; that one accordingly does enter, keeps itself there, and grows; that afterwards, the egg, become thereby heavier, detaches itself by its own weight from the ovary, and falls down into the matrix. But, must not this explanation appear exceedingly forced, when we reflect, that before it can be admitted, we must suppose, contrary to all probability, that although all the pores of the egg are open, there enters but a single animalcule; or that, if many enter, only one of them grows there?

There is something very singular in all this; and an opinion, destitute of proofs, and which, in order to be supported, must have recourse to vague and forced suppositions, is not likely to gain ground.

Let us reflect further in the seventh place, on the conduct which this opinion obliges us to ascribe to the Creator. It presupposes that this omniscient being, in order to produce a single perfect animal, has been obliged to form so many hundred thousand imperfect beings that the number is inconceivable. Does such a conduct correspond to that which we see reign in the other operations of nature, where all things tend to their ultimate perfection by the most direct, the simplest and shortest course?

I know that the ways of God are not as our ways; that it would be culpable temerity to condemn his works because they are not conformable to our ideas, and that tho' we do not comprehend the reasons which may have induced the supreme Being to act in such a particular manner, we ought not to be the less convinced that these reasons have been conformable to his infinite wisdom. If therefore it were demonstrated, that generation takes place in the manner which Leewenhoeck and his followers pretend, far from impugning, I should consider it as the strongest proof possible that the thing was so. But I know likewise on the other hand, that when on the strength of our own weak reason, we would attempt to account for the operations of nature, the respect we owe the Creator should render us careful not to attribute to him a conduct which we can suppose unsuitable to the ideas we have of his adorable wisdom; and in this view I think the system in question faulty.

It will perhaps be objected to me, that what I here condemn as a fault in the System of Leewenhoeck we have nevertheless very frequent examples of in plants, which produce incomparably more seeds than are necessary for the preservation of their species, and of which a great part perishes without having contributed to this purpose. But if we bestow a little attention we shall find that this example has no relation to the present case. For besides that there is no proportion between the number of spermatic worms which are produced in a single animal, and that of the seeds produced by the most fertile plants, the seeds of vegetables are not destined merely for the preservation of the species, they are likewise destined for the nourishment of animals. They make the principal part of the food of man, and of the greater part of the food of birds; this is a fact we know, but we do not see how the prodigious number of animalcules, which

perish

perish in the uterus, can be of the same use there. Add to this, that as plants have not the power of sowing their seeds in the earth, and that thus after they are shed, many of them perish for want of being sown, it was necessary that plants should produce a quantity of seed sufficient to make up for this loss; besides we may say that if any seeds perish, this happens only by accident. There is hardly any seed which, when thrown into the ground, does not produce a plant; but it is quite otherwise with spermatic worms. If they perish it is by necessity, and of so many hundreds of millions which enter into the place said to be destined to receive them, there are only a few which, according to the system of Leeuwenhoeck, can become large animals.

To all these difficulties which regard animals in general, there are others which respect man in particular. It is allowed that the animalcules, of which it is pretended man is formed, are living, animated beings. I ask what is the nature of the soul which animates them? Is it the soul of a brute? Is it a soul endowed with reason? If it be the soul of a brute, then is man composed of three distinct principles, a body, the soul of a brute, and a soul endowed with reason. This is what I suppose the advocates for the system of Leeuwenhoeck will not admit, and which would indeed be an opinion too singular to be admitted without proof or foundation. But if it is a rational soul, and the same which animates our bodies, as Leeuwenhoeck makes no difficulty in averring, can we conceive, that in order to form our body, the least noble part of us, God created so many myriads of rational souls, all except one or two destined to destruction? Would that accord with the notions we entertain of his infinite wisdom? I shall be told perhaps, that while these souls reside in the animalcules, they have not yet acquired reason, and that they do not acquire it but by degrees from the knowledge the man receives as he grows up; at least it is thus that a disciple of Wolfius would reason. But this would not remove all the difficulty. The soul of the animalcule would always be essentially the same with that of man; it would always be a soul capable of receiving the perception of objects as they should be presented to it, and of reflecting on those objects. All the difference would be, that in the body of the animalcule those objects would be presented to it fewer in number and more obscurely; but this defect, which proceeds from the condition and imperfection of the body

in which it is found, does not diminish the intrinsic value of the soul, which would always be capable of reason, and in this respect a being very superior to matter. This is not all; those souls being endowed with reason, or at least capable of reason, and the same which animates us, they would also be immortal. What would be their condition after this life? A Protestant might find in the satisfaction of Christ, and in the divine mercy, a means of salvation: but what would those of the Church of Rome do with them? According to the principles of their doctrine, they would deprive of eternal happiness, and banish to a place similar to what they call the Limbus of the Fathers, those which had received existence in the body of some one of their religion; for to save them is impossible, as they have not been baptized. And for those who have had the misfortune to be placed in persons born out of the bosom of this Church, I have no doubt but they would damn them without redemption. Here then for a member of the Church of Rome who should adopt the system of Leeuwenhoeck, the number of the Reprobate, who have never known good nor ill, becomes a thousand million of times greater than that of those who have become so by their own crimes; and yet the number of the Blessed is not encreased by a single individual. What a horrible idea! and how little it accords with the sentiment which we ought to entertain of the goodness, mercy and even justice of the Being of beings! I believe if Mr Andri had considered this when he wrote in favour of Leeuwenhoeck's system, the pen would have fallen from his hand and he would have suppressed that part of his Work. Since then the system we have been examining seems to be founded merely on conjecture without any proof; that it appears replete with difficulties, and contrary to probability; that it is derogatory to the ideas we ought to entertain of the perfections of the divine majesty, I think we may reasonably refuse to adopt it; or at least not till some solid proofs have been adduced in its support. In the mean time, the discovery of the animalcules we have been talking of, furnishes us with a noble opportunity of admiring the wonders of the Creator, who has thus formed the larger animals, not only to serve the final purposes of their destination, but to be, without knowing it, as so many worlds peopled with an infinite multitude of inhabitants.

Page 86.

PAGE 86, l. 18.

* *Whom their cruel country had expelled.* The instance here adduced by the author is striking, because it is later than some others, and has happened in our days. But if we go back to the last century, and reflect on the vast multitudes of Protestants who were banished from France their native country; who were at first destitute of every thing, but who soon found a retreat in Germany, in England, in the United Provinces and in Switzerland, we shall be convinced that Providence did not abandon them any more than the people of Salzburg. The greater part of the French found themselves in a short time in a situation infinitely more agreeable than that which they had left. This fact is so true, that numbers would have refused to quit their new establishment, though they had been permitted to return to their native country. Thus God accomplished in them the promise he made to those who should leave father, mother, wife, children, &c. for his sake. He repaid them an hundred fold. *Note of the French Translator.*

PAGE 87, l. 11.

A sort of moving house. If there be animals, which after having got entrance into our bodies with our food, increase there and multiply, it is probable that their number cannot be great, considering that an animal brought to life in a temperate air, and accustomed to a certain kind of food, appears little fit to endure the heat of our stomach, the corrosion of the solvent humours which enter it, the humidity and moisture with which it is filled, the trituration and great diversity of the aliments which are there digested. All this seems likely to cause its death in a few instants; accordingly it is with difficulty I can believe that the worms which are so often found in our intestines have been introduced with our food; although it is very difficult to say how they have got admittance otherwise, and tho' all that has been advanced on the subject hitherto is nothing but conjecture, and that too sufficiently improbable.

PAGE 87, l. 29.

Ready to devour our bodies. The worms which commonly attack our dead bodies are not the same which inhabit them when living. The origin of these last is unknown to us; but we know that the first are produced from flies which

lay

lay their eggs on flesh, and other substances about to grow putrid. Before the corruption of those substances they are not proper food for the larvæ of these flies, and accordingly they never deposit their eggs on living bodies: and it is sufficient to prevent a dead body from being eaten by worms, to defend it from flies. As to the worms which are found in our bodies while alive, it is probable that they die with us, and that our bodies when become cold and corrupted, are incapable of preserving the life of animals accustomed to a great degree of heat and to fresh food. What confirms this idea, is, that we see lice and other vermin which prey upon living bodies, abandon them when dead, and even when attacked by disease.

PAGE 88, l. 15.

The motion of snails is very slow. The mechanism of their progressive motion is more curious than is generally imagined, at least if it resembles that of the large spotted snails which I have examined. When they are made to move in a glass, we see their under surface divided into three bands, which run from the head to the tail; the middle one alone seems to act; all the motion at that time observable in the other two is only that by which they apply themselves immediately to the bodies they pass over. The action of the middle band consists in a very obvious undulating motion, very regular and rapid, proceeding from the tail to the head, the undulations succeeding one another at equal distances, and so near, that twenty of them may be counted between the head and the extremity. The body of the animal obeys but little the rapid motion of these undulations. It appeared to me, that during the time occupied by an undulation, in running the whole length, the animal itself proceeded only the space between one undulation and another. Its progressive motion is therefore twenty times slower than the undulatory motion, and it may be said that to advance one step, it must make twenty. Who could imagine that this animal runs so fast, when it proceeds so slowly!

PAGE 89, l. 11.

The blind mole. Moles are by no means blind, but their eyes are not formed to bear the light of broad day. They are very small, and deep seated; they must be sought for to be seen. It was necessary that they should be thus hidden to defend

defend them from the falling in of the earth, in which this animal is continually digging. It is this wiſe precaution in nature, which makes people believe that moles are blind; they would become blind if they had leſs the appearance of being ſo.

PAGE 90, l. 14.

To prevent their falling to the bottom. Aquatic inſects are not confined to a ſingle mode of progreſſive motion. Many walk, ſwim, and fly, others walk and ſwim, and others poſſeſs only one of thoſe means of motion. Of thoſe which ſwim, the greater part ſwim on the belly, and ſome on the back. To ſwim the more quickly, ſome have the power of filling themſelves with water, and of ejecting it again forcibly by the poſterior extremity; this puſhes them forward with an effect ſimilar to that which puſhes back the Eolipile, or makes a rocket aſcend. In this way the larvæ of the Libellula Puella ſwims. Others have the hind legs long, and made like oars which they uſe in the ſame way. Of thoſe which walk, ſome go on the belly, others on the ſides, and others on the head and the tail. Inſects of this laſt ſort have no feet, they have a ſort of limb at each extremity of the body which ſerves them for feet, and by which they can attach themſelves with inconceivable force to the bodies they want to hold by. Some ſpecies of this kind have the power of elongation and contraction, in a degree which exceeds imagination, and this makes them take huge ſtrides. Many aquatic inſects properly ſpeaking neither walk nor ſwim; but by a progreſſive undulation of the under part of their body, they can produce the effect. There are even ſome that without the ſmalleſt obſervable external motion glide through the water in every direction and with great velocity. Many of theſe are Proteuſes which change as it were their form at pleaſure, and take ſuch odd ſhapes that if one did not know them, one would never take them for animals.

PAGE 91, l. 3.

Like a bow after the arrow is let fly. What facilitates this elaſtic motion is their having hooks at their anterior part by which they connect themſelves with the poſterior part of their bodies. When they make an effort as if to reſtore themſelves at the time that they are bent double, theſe

these hooks at once loose their hold, and cause those jerks by which the animal leaps from place to place.

Page 92, l. 21.

Excepted from this general rule. In this example it is remarkable that the insect is a butterfly, and that butterflies in general have a very uneqnal mode of flight, much more so than moths. Perhaps the reason is that the four wings of the former are almost inflexible, and quite extended; while the latter, at least the greater part of them, can fold their wings like a fan; which may help to direct their flight.

Page 92, l. 24.

The flight of the male being most rapid. There are even among butterflies and beetles some species where the females do not fly at all, as has been already mentioned.

Page 96, l. 2.

They all dread the rigour of winter. The Winter however is formidable but to few species of insects. Besides that the greater part resist the most intense cold, and that a severe winter kills fewer than an open one, I have already said in another place that there are many kinds for which the season of frost is the season of eating and growing: there are many caterpillars of this kind. I am suprised to find them mentioned by no author; probably because they have never thought of seeking for them in that severe season. Winter insects grow much more slowly than those of the Summer. They do not eat when the frost is very intense, but they immediately begin to feed when it grows more moderate. It is generally towards spring, that they transform themselves into nymphs or chrysalids.

Page 96, l. 19.

Seen assembling in crowds. This relates only to certain species aceustomed to live in society. We do not find insects that live solitary, and which are certainly the most numerous, assembling together to pass the winter.

Page 97, l. 3.

* Dr Welsch mentions a beautiful jasper which on one side had many deep and winding holes, visibly the work of certain

certain insects which had lived in them. Besides, a certain yellowish dust in them indicated that they could only have been the holes of worms; and Barchewitz says that a species of white ants in the East Indies live on iron.

Page 63, l. 13.

Sand, stones, iron. These substances appear so little fit to be food for insects, that one would need at least better proofs than those which the author has brought, to credit a fact of this nature.

When an insect works in the sand, a careless observer might easily be deceived, and imagine when he sees the animal taking sand in its mouth that it is for the purpose of eating it, though in reality it is only for constructing its habitation.

A stone full of holes, or which appears to have been attacked by some insect, is not a valid proof that that insect has used it as food. Some insects indeed build the cases in which they live with fragments of stone and other hard substances. Is it not probable that if any insect had attacked the jasper which the author mentions in the above note, it must have been only to construct its abode with the fragments, or to form a lodge for itself in the stone? But it is not even probable that insects ever lodged in that jasper, except they had done so before its compleat petrifaction. Nothing is more common than to find fishes, bones, shells and other animal substances in the heart of the hardest stones. But it must not be inferred from this, that those fishes, or the animals to which those bones and shells belonged, ever lived in the stones, or were nourished by them. It is certain that they must have got into the stones before their induration. If then the jasper in question had been formed around the insects, time would consume them, the holes they occupied would remain open, and their remains in the form of dust might be found in them.

As to iron, which Barchewitz pretends the white ants of the East Indies live upon, the circumstance is so incredible, that it would be judging charitably of that author to suppose he had been mistaken.

Page 98, l. 18.

The scolopendræ. The various larvæ which live in dung-

hills, are not attacked by Scolopendræ alone; they likewise serve for food to many sorts of larvæ with six feet.

PAGE 98, l. 21.

The hairy caterpillars. The tree bugs attack indifferently all sorts of caterpillars; and I have even seen some of them seize upon butterflies, and suck their fluids.

PAGE 98, l. 26.

Flies are also found. That a large fly should kill and eat a small one is not very singular; but it is more surprising to see flies, that are apparently very weak, attack and overcome voracious flies much larger than themselves. This however is done by a fly which in size, and form, resembles the Panorpa. I have seen it in the air dart upon a dragon-fly ten times larger than itself, and bring it to the ground. The success of the combat was not doubtful. The dragon-fly thought of nothing but escape, while the other stung it so forcibly, that it would soon have been finished, had not the desire of possessing them both made me interfere. I lost them both, but it was easy to see by the flight of the dragon-fly, that it had been very rudely treated in the encounter.

PAGE 98, l. 28.

The ichneumons kill spiders. I do not know that there is more than one species of Ichneumon that kills spiders. But I know for certain, and I believe I have already mentioned it, that there are many kinds of them which prey on other insects.

PAGE 98, l. *penult.*

Beetles feed on the aphides. These have three sorts of enemies still more formidable, to wit, the small ichneumons, the larvæ that feed on the aphides, and the Hemerobius. These two last, of which there are many species, destroy a prodigious number of aphides.

PAGE 99, l. 23.

* *No other nourishment than the fluids they suck.* It has been thought that spiders only suck the juices of the insects they kill, because they do not eat them entirely; but Lister thinks that they also eat the solid parts. De Aran. P. 44.—In liquido,

quido, &c. "In the liquid and whitish excrement of this spider, there were several black particles to be observed, which were the useless and indigestible skins of beetles and flies; it is not therefore probable that these animals live by mere suction, but that they also devour a great part of their prey."

PAGE 99, l. 33.

* *Some drink, as grasshoppers.* This fact was known to the antients Grasshoppers drink the drops of dew that adhere to leaves, after having first examined them with their antennæ.

PAGE 100, l. 20.

Continue at rest during the day. This state of rest is carried to such a degree, that many species of Phalænæ give no signs of life, even when they are touched in the day. But the evening no sooner arrives, than they are almost in perpetual motion.

PAGE 100, l. *last.*

They spring upon it with amazing velocity. I have seen a species of spider do this. It forms a small cavity in the sand which it lines internally with a kind of silk to prevent sand from falling in. It lies in wait at the mouth of this hole, and when a fly lights near it, even at the distance of three feet, it runs out upon it with astonishing velocity, seizes it, and drags it to its den.

PAGE 101, l. 7.

* *The manner in which they kill.* The large hornets lay hold of spiders and caterpillars by the neck, and grasp them in such a manner as to prevent them from being able to defend themselves, and so transport them to their holes: if the insect seized makes still too much resistance, a second application of the hornet's maxillæ soon finishes the combat. The Author.

Wasps, and especially hornets, do not content themselves with wounding spiders with their teeth before carrying them away. I have often seen them dart into the webs of the largest spiders, and after having thrown them on the ground tear away their legs, and fly off with the mutilated trunk. Lyonet.

PAGE 101, l. 15.

Secure them as in a granary. Among the insects which feed in winter, those only which live on substances not to be found in that season, use the precaution mentioned by the author. It is easy to believe that those which feed on rotten straw, or dead leaves and grass, make no magazines, but eat those substances where they find them.

PAGE 101, l. 32.

The proportion is so well preserved. This proportion however is not always constant. Circumstances favourable to certain sorts of insects, make them sometimes appear in such multitudes, that after having devoured all the verdure fitted for their nourishment, the greater part die for want. Those only which have been first hatched escape and preserve the species for the coming year; this is what makes it very uncommon to see a too great quantity of insects of the same species for two years running.

PAGE 102, l. *penult.*

Have received a sort of pump. There are many kinds of voracious insects, that have at first sight neither mouth nor proboscis, nor any apparent opening through which it can be supposed that they can draw their nourishment. One would almost imagine that they live on air, if two large pincers in the form of a crooked horn, which they have on their head, did not indicate that they feed on something more solid. These pincers serve them for both mouth and trunk; they are hollow, and pierced or cleft at their extremity. They plunge these into the bodies of those animals they live on, and suck through them the whole substance of their prey.

PAGE 103, l. 7.

Real Epicures. I know caterpillars that in less than four and twenty hours eat double their own weight.

But an example of gluttony much more remarkable is in those drones, which even when cut through the middle do not cease to gorge themselves with honied liquors if set before them, although what they swallow runs out at the wound.

*The Dermestes lardarius is so voracious, that though sometimes there is seen hanging from him a string of excrement

crement, a yard long, he does not give over eating.—Frisch.

PAGE 103, l. *penult.*

Dispense with food. Add, or to live on what they can find, during winter.

PAGE 107, l. 28.

Disgusts their enemy. *A few years ago, as I was touching the horn of a certain caterpillar, which has one on its back, it turned about its head suddenly, and discharged upon my hand a quantity of a green liquor, viscid, and so fetid, that though I several times washed my hand with soap, and rubbed it with sulphur, I could not get rid of the smell for two days.—The Author.

That insects, in order to rid themselves of an enemy, should discharge, either by the mouth, or their posterior extremity, a fluid of an offensive smell, is not surprising. Nature furnishes us with examples of the same kind, in some of the larger animals, and the food used by insects, procures them the matter ready formed. But to find, that Nature has likewise taken care to provide, in many insects, a great number of reservoirs, having their orifices on the upper part of their bodies, and which contain a fetid liquor, ready to be discharged on all assailants, one would not so readily expect. I know large caterpillars, producing Tenthredos, which, when they are teazed, eject to a good distance, from different parts of their body, a disagreeable fluid, fit to put to flight their aggressors. Various sorts of larvæ which produce beetles have, upon their body, many different rows of tubercules, open at the extremity, and when they are touched, there appears at the end of these tubercles, a drop of milky juice, of the most insupportable smell. These drops, however, seem to be very precious to them; no sooner does the danger disappear, than they take care to draw it in again, by the same channels through which it issued. What a strange method of defence! But, it is not altogether peculiar to insects, for we find an instance of it in those lizards which have been called Salamanders, though they are by no means able to live in fire. These reptiles, when they are pressed somewhat rudely, or when they are brought near

near a fire, suddenly contract their skin, and a white viscid liquor issues through its pores, by which they endeavour to drive off their enemy, or to defend themselves from the heat.—Lyonet.

PAGE 111, l. 35.

**Wrap them up, as in a cloak.* There are little yellow caterpillars, with a red band, which live on the hundred leaved rose, that weave a web round their eggs, and then die. The Author.

• What M. Lesser takes here for the eggs of caterpillars, are coques made by the larvæ of an ichneumon. Caterpillars never lay eggs, till they are metamorphosed into perfect insects.—Lyonet.

PAGE 112, l. 10.

**Defend them by various ways.* The Grillo-talpa deposits its eggs in a hole it makes in the middle of a pretty hard hillock of earth. It surrounds this hillock with a kind of ditch, to make the approach to its nest the more difficult.—There it watches continually, and from time to time takes a circuit round, to see that all is safe. Reaumur Tom I. Mem. I. The Author.

Although the facts mentioned here, are to be found in Reaumur, they are not confirmed by that illustrious author. He only cites them from Goedart, and considers them merely as a pretty fable.—Lyonet.

PAGE 112, l. 15.

Cannot come from the animal. As we do not know, whether God has not bestowed some degree of knowledge and reason on brutes, and as the affirmative is at least probable, it seems wrong, so positively to assert the contrary. But whether we suppose, that insects act from reason, or that they are constrained to act as they do, by a blind instinct, the glory of God is not the less conspicuous in either case. In the first, we cannot but admire the wisdom of the Creator, who has made machines which, without reason, can act as consequentially as if they were endowed with it; in the other, we must admire the same Wisdom, that could create so many different sorts of beings, of more limited knowledge than we are, but, nevertheless, sufficiently intelligent to provide for their own preservation, and that of their race. In the

the first case, God has exalted the organic mechanism, to a degree of perfection, which matter alone does not seem capable of attaining; in the second, he has raised the brutes, to a pitch of perfection, superior to what we can conceive of organic mechanism.

PAGE 113, l. *last*.

Is there any thing similar among insects. We cannot but praise M. Lesser, for seeking, even in the conduct of insects, arguments to dissuade us from vice; but one would think, he did not perceive, that his zeal made him argue against his own principles, and that he cannot set in opposition what is praise-worthy in the actions of brutes, to what is blameable in those of men, without supposing, that they act like him, by some motive of reason. Would it, for instance, be decent to exclaim, one mill does not destroy another mill; a watch does not destroy another watch; that it is shameful in men, to make war upon, and to destroy one another? This, however, would be a mode of reasoning, ridiculous as it is, similar to that of those, who, supposing that beasts are but machines, would oppose their conduct to ours. One of two things must therefore be chosen; either not to compare man with the brutes, or to allow some degree of reason to these last.

But, to come to the example of insects, here stated, it is by no means astonishing, that we do not see them kill their young; since the greater part of those that are best known, are such as die before their eggs are hatched. As to those which survive the birth of their young, there are examples of their actually preying upon them, when they have an opportunity, and others, that, though part of the same litter, devour one another, without necessity, and from excess of gluttony. We have only to keep, for some time, a spider with its young, under a glass, and we shall see an instance of both cases.

PAGE 115, l. 18.

In the formation of their nests. Insects fabricate those nests, or those habitations, which the author is about to mention here, for three very different purposes, and which it is proper to distinguish. The first purpose is, when they make them to live in, during their larva state, when they eat and grow in bulk. These habitations are then generally

ly cases open at both ends. The insect lodges there, enlarges them as it grows, or makes new ones. But it is not those which insects make, by rolling leaves together, which are the most worthy our admiration. The cases, made by the land and water larvæ of certain moths, of different kinds and species, are master-pieces, in which art and arrangement often appear much more conspicuously.

The second purpose for which insects construct habitations, and which is, too, the most frequent, is, to be the place where they undergo their transformations. These sorts of habitations are commonly called coques or cones. They are generally in the form of oblong spheroids or approaching to that form: there are, however, some of a different figure. The insect shuts itself up in these, and leaves hardly any apparent opening. Some, indeed, are so solid, and so well formed, that they are quite impenetrable by water or air: it is here that the insect changes into a nymph or a chrysalis. These coques seem to serve principally three ends. The first is, to furnish, by their internal cavity, a convenient support to the chrysalis or nymph, as soon as it appears, and while its cover is still tender, and to enable it to assume the attitude, somewhat bent anteriorly, which is necessary to make its members, particularly its wings, take the place in which they are to remain fixed, till the insect rids itself of its cover. They serve, in the second place, to defend the animal, in that state of weakness, from the injuries of the air, and the pursuit of its enemies; and lastly, they prevent those chrysalids or nymphs, from drying by a too great evaporation: those coques, which have hardly any consistence, probably serve only the first of these purposes. Those which are firmer, but without being impenetrable to air and water, seem likewise to serve the second purpose, and the rest seem destined to perform the three different ends, according to the different necessities of various insects.

In the structure of those coques, there is often observable an art and industry altogether wonderful, and as if one alone was not sufficient to protect the insect, there are some which have two, and even three, one within another, fabricated all by the same animal, and not by different insects, as happens, when an ichneumon, after having caused the death of an insect, which had already made its coque, and having afterwards made its own, has been destroyed in its

its turn, by a ſecond ichneumon, which it harboured in its intrails; this caſe it is eaſy to convince ourſelves of, becauſe the exuviæ of each of the deſtroyed animals, is found between the coque which it has made, and that of the inſect which deſtroyed it.

The third uſe of theſe neſts, is, for a covering to their young. This uſe is the leaſt frequent. Spiders furniſh us with the moſt common example of it, and perhaps the only one known. The large Dytiſcus piceus, however, makes a much more remarkable one. The neſt of this animal is whitiſh, and its general figure that of an oblate ſpheroid, the long diameter of which may be about three-fourths of an inch, the ſhort one fully half an inch, and there appears as if a ſegment, parallel to this ſhort diameter, were taken off. Near this place the young, ſometime after being hatched, make an opening, and plunge into the water. Higher up, on this coque, there iſſues a ſort of horn, browniſh, and ſomewhat bent, about an inch long, broad at the baſe, but terminating in a point. I imagined at firſt, that the uſe of this might be to give air to the coque, that the young, which cannot diſpenſe with it for any time, although they live in water, might be able to breathe, the moment they leave the egg; but, having examined theſe horns with more attention, and having ſeen the Dytiſcus forming them, I found they were ſolid, and I could attribute to them, no other uſe, but that of retaining the coque in its ſituation, when a blaſt of wind, or any other accident might otherwiſe overturn it. For, as theſe coques generally float among reeds, or the duck-meat, if any thing ſhould lay them on their ſide, their horn then reſting on theſe ſubſtances, prevents their turning upſide down, and, the form and weight of the coques make them ſoon regain their upright ſituation. This coque is the more remarkable, being the work of a Dytiſcus, a kind of animals, among which one would not have expected to find any, that could make ſuch neſts; although the ſpecies here mentioned is not the only one known to me, that does ſo. I do not reckon here, among the neſts of inſects, the ſlimy ſubſtance which envelopes the eggs of ſome ſorts of water inſects; becauſe ſuch coverings appear to be rather owing to Nature, than to their induſtry; though the regular arrangement of the eggs ſeems to be the effect of their labour.

PAGE 115, l. 19.

**All sorts of substances*. Frisch discovered the larva of an insect in fresh water, which constructs a moveable habitation to itself, in the form of a tube, of fragments of grass, wood, bark, leaves, &c. In this it lives, not as snails do, in their shell, which they cannot leave; it goes in, and comes out, at pleasure. The inside of its house is smooth, and polished with the greatest care, the outside rough and rugged. To close the entrance, there is a lid, which fits it exactly. When the animal changes its place, it carries the house along with it, sometimes with its feet, but if that is not sufficient, with its teeth. Frisch had not been able to discover the insect produced by this larva.

PAGE 119, l. 8.

About five lines. This observation would be just, if the common base of the two ranges of opposite cells were flat; but, as it is composed of solid angles, concave and convex, which serve alternately for a bottom to the opposite cells of the comb, so that the bottom of each cell, exceeds by so much, that of the cells which are in a contrary position, it follows, since the base of these cells is so exceedingly thin, that, when the thickness of the comb is nearly an inch, the cells which compose it should be, at least, half an inch deep.

This appears more distinctly by the Fig. XIV. which represents the section of a comb, composed of eight cells, placed opposite to one another on their common base. Let A B be the thickness of the comb D E, and C B, the depth of the opposite cells which compose it, and let E F be perpendicular to A B. It is evident, that A B=A F+C B—C F, or A F—D E, therefore, A B=D E+C B—C F, that is to say, that the depth of the two cells, X and Z, taken together, surpasses the thickness of the whole comb, A B, by the part C F; so that, if the thickess of the comb was an inch, the depth of each cell would exceed half an inch, by nearly the half of C F, and would by no means be less than six lines, as M. Maraldi asserts.

PAGE 120, l *first*.

The base of each cell. Although the description here given of the manner in which the cells are constructed, is very exact, yet, as it is not elucidated by any figure, it will be

Fig. I.

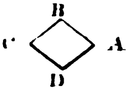


Fig. II

Fig. III

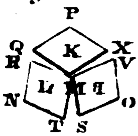


Fig. IV

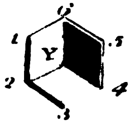


Fig. V

Fig. VI

Fig. VII.

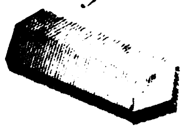


Fig. VIII

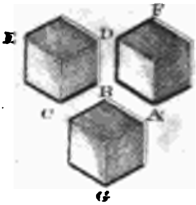


Fig. X

Fig. IX

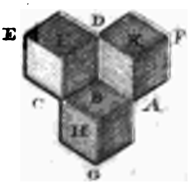


Fig. XII

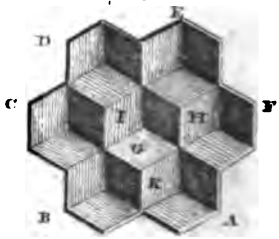


Fig. XI

Fig. XIII

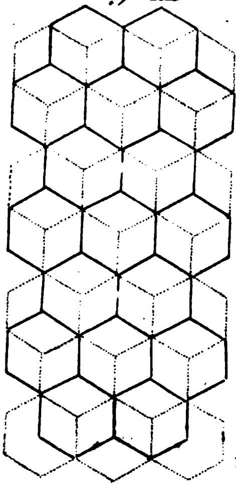
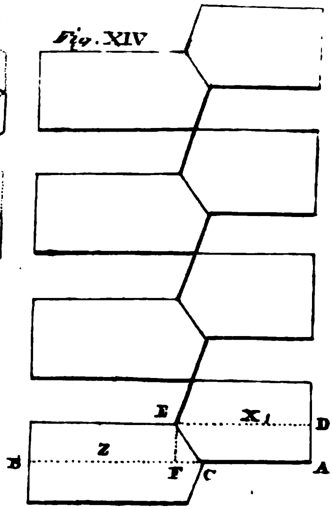


Fig. XIV



with difficulty comprehended; I have therefore thought it necessary, to represent, by the annexed plate, the figures which the author describes.

The structure of a cell seems at first sight very complicated, though it is made up of only two different pieces; the first is, the rhomb, Fig. I. the obtuse angles of which, according to M.Maraldi, are each of 109° 28′, and the acute ones, A and C, each of 70° 32′: the other is the Trapezium, Fig. II. the side of which, G H, is equal to one of the four sides of a rhomb; the side, G E, equal to the depth of the cell, together with the hollow of its base; the angle, H, equal to each of its obtuse angles, and the angles E and F are right angles. Three rhombs, equal to that of Fig. I. form together the base of a cell, and six of the trapeziums compose its sides.

In order to comprehend how these rhombs form a base, imagine the three rhombs, I K L, Fig. III. placed on the same plane, so that any three obtuse angles shall meet in one point, M; then, leaving these three angles in their point of contact on the plane, raise the three angles, N O P, so that the side, M Q shall unite with M R, the side M S, with M T, and the side M V, with M X, then, from the junction of these three rhombs, thus elevated, there will be formed, the solid concave angle, Y, Fig. IV. which, turned upside down, will be the solid convex angle, Z, Fig. V. the first of which will be the base of a cell, having its mouth uppermost, and the other, of a cell having its mouth downwards. Place, on the six external sides, 1, 2, 3, 4, 5, and 6, of these three rhombs united at the base, Fig. IV. as many such trapeziums as we have described, raised perpendicularly to the plane, so that, their acute angles shall meet the acute angles of the rhombs, and the obtuse angles of the rhombs, the obtuse angles of the trapeziums, which may be easily done, by turning the six similar trapeziums, one within the other, alternately outwards, then, by the union of these nine pieces, will be formed, the hexagonal cell, represented in two different situations, Fig. VI. and VII. to give a more distinct idea of it.

Now, to know how several cells are connected, imagine, in the first place, three concave bases, B A F D, B D E C, B C G A, Fig. VIII. such as we have described, and set upon the same plane. If you join them together, each by the obtuse angle of one of their rhombs, so that the three angles

angles you have taken, ſhall meet in one point, B, Fig. IX. then their ſides, B A, B D, B C, will unite and become common, in the ſame manner as the trapeziums which you are afterwards to raiſe on them, joined to the other trapeziums, placed on the external ſides of the three united baſes, will form three contiguous cells, as in Fig. X.

It will be eaſily conceived, that, by joining in the ſame manner, other baſes to the three here mentioned, they will become the bottom of as many new cells as may be joined to the firſt, by their common ſides, and this may be carried on at pleaſure.

It remains to know, how the baſes of cells make part of the baſes of thoſe oppoſite to them. For this purpoſe, conſider again, the three united baſes of Fig. IX. which form each a ſolid cóncave angle, K I H. You will ſee, that, by the union of the three rhombs, A D, D C, and C A, which meet in B D, B C, B A, they conſpire to form in B, a ſolid concave angle, equal to each of the three ſolid concave angles, K I H, the poſition of which is reverſed. It is this angle, B, which makes the bottom or baſe of an oppoſite cell, and the ſix exterior ſides, A K D I C H, of the three rhombs, A D, D C, C A, which compoſe this angle, ſerve for ſupport to the ſix trapeziums, which ſhould be raiſed on them, and form by the union of their ſides, a cell reſting on three others oppoſite to it, as in Fig. XI. where the cell is repreſented erect, the better to ſhew the way in which a cell reſts on three others. And, as by joining many baſes, the angles of which are ſolid and concave, theſe baſes, by the junction of their external ſides, likewiſe form convex angles, ſimilar to the firſt, it follows, that ſeveral baſes of cells united, which belong to one of the rows in a comb, form by their junction, ſeveral of the united baſes of the oppoſite row. Thus, in Fig. XII. the union of the ſeven concave baſes, A, B, C, D, E, F, G, form the convex baſes, H, I, K, of the three oppoſite cells.

To give a more diſtinct idea, ſtill, of the manner in which the two rows of cells in a comb, are placed on the common baſe of the comb, I have added figures XIII and XIV. Fig XIII repreſents the plan of a part of the baſe of a comb; the hexagons, marked with dots, indicate the poſition of the cells of one row; and the hexagons with lines, that of the other row. Fig. XIV. is a ſection of the ſame comb.

PAGE

PAGE 124, l. 23.

These tumours vary in appearance. These tumours are generally named galls, and are of many different kinds: the gall-nut, so well known for its various uses, is one species of it. M. de Reaumur describes several of them, in his Memoires, Tom III. his observations are exceedingly curious, and deserve to be read.

PAGE 125, l. 4.

Choose a place, where they may be secure. That place of retreat is generally the earth; the greater part of insects, which pass the winter without eating, and in their nymph or chrysalis state, retire into habitations which they make there, each in its own way.

PAGE 125, l. 30.

Or by the mouth or abdomen. It is not properly by the mouth, that these insects spin their webs; it is by an apparatus which they have under their mouth. Spiders, and the insects of the genus Hemerobius, draw, from the extremity of their abdomen, the silk of the coques in which they inclose themselves. Some species, likewise, of Dytisci, do the same, in order to construct the nests in which they lay their eggs.

PAGE 125, l. 31.

Or by the abdomen. This is the way in which spiders extract the matter of their webs. Those larvæ, called by the French, Pucerons-lions, likewise draw from the extremity of their abdomen, the silk of which they make their coque, and in which they inclose themselves. Some species of Dytisci likewise do the same to fabricate the coques in which they deposite their eggs.

PAGE 125. l 34.

Others are coarser. Spiders have the power of spinning their threads, either fine or coarse, as they please, by drawing from their bodies, as many threads as the occasion requires, and joining them together: those which spread their nets in gardens, can even spin two sorts of threads, the one glutinous, the other not: this we can assure ourselves of, by throwing dry sand on their web: we shall find, that the sand

ſand will ſtick only to thoſe threads that turn ſpirally, but will by no means adhere to thoſe that run ſtraight acroſs the web.

PAGE 126, l. 12.

As ſkilful dyers. It is not in the option of inſects, to paint or vary the colours of their ſilk, at their own pleaſure: this depends on the nature of the ſilky matter which is formed in their entrails. It is this, and not the inſect, which gives the colour to their thread. Beſides, what is ſaid here, of the beauty of theſe colours, is applicable, only to a few of theſe animals; the ſilk which moſt of them ſpin, is of a very ordinary colour, and much inferior to that which a good dyer could give them.

PAGE 127, l. 7.

The wiſe form of government. What authors have advanced, on the conſtitution and government of bees; on the authority of their king; on his ſkill in the art of reigning, on the obedience paid by his ſubjects, and on many other things of this nature, is ſo fine, ſo marvellous, that it ceaſes to be probable. Suppoſe theſe circumſtances to be nothing but ingenious fictions, as there is every reaſon to believe, it would not be difficult to trace their origin. People have at firſt admired the art with which bees conſtruct their combs and have, from that, conceived very high ideas of them: they have ſeen them living in ſociety, and labouring in various ways for the common good; from this it would be inferred, that they have laws and eſtabliſhed ranks: having found in their ſwarms, ſome bees larger than the reſt, theſe would be conſidered as kings; ſeeing thoſe ſurrounded by a number of other bees, theſe would be courtiers or guards, or ſubjects coming to receive orders, and to execute them; in a word, no particular has been obſerved, in the economy of bees, that has not received an interpretation conformable to the high ideas conceived of them, and to the monarchical ſyſtem, under which it ſeemed certain, that they lived. But, what would be our ſurpriſe, when, after having attended more cloſely to the behaviour of this king, and having dared, even to lay hands on his ſacred perſon, to find his body full of eggs, and to ſee his principal occupation, that of laying theſe eggs in the empty cells! From theſe circumſtances, unprejudiced perſons

sons would not hesitate, to declare him deprived of all regal authority; but old prejudices are not so easily given up; these ideas of monarchical government have remained; not being able to make a king of this bee, they have made it a queen; and thus, this empire, which had been governed, for so many ages, by an uninterrupted succession of kings, has at last had the misfortune, to fall irretrievably under the distaff. After this disaster, I am afraid, that the monarchy of bees is hastening to its period, and that soon, when the royal authority shall have declined, the queen will be considered merely as a mother, her subjects, merely as a free people, and this well governed state, as nothing but a hive of bees and drones, which, constrained by instinct, attach themselves to one, two, or three females, according to the number of the swarm, for the preservation of their species; and who labour in concert, each according to its destination, some to generate their like, and to bring them into the world, others to preserve them. This, at least, is the state, to which the celebrated Swammerdam reduces them, who studied them, with great application, and has treated largely on the subject, in his Biblia Naturæ. There is reason to believe, that he thinks justly in this case.

I must observe, that it does not appear, by the passages *which the author refers to* from Aristotle, that this ancient philosopher knew, that what is commonly called the queen bee, was a female: the generative faculty, which he attributes to her, is no proof of this, as it depends, as much on the male, as on the female. Besides, he always gives her the name of king, and not of queen, which he probably would not have done, had he known that she was the mother of the bees.

Page 132, l. 7.

They expell the drones. There are three sorts of bees in a hive; the mother-bee, the drones, which are the males, and the common or working bees, which are of no sex. It has not been hitherto ascertained, that I know of, if the drones couple with the mother-bee, or whether they merely deposite their semen on the eggs she has laid. Swammerdam was inclined to think, that they render her fertile, by the mere odour of their semen, which is by no means probable. At any rate, these drones, after having been well fed, without having wrought any, during a considerable part of the spring

ſpring and ſummer, become, towards the end of the ſeaſon, objects of perſecution to the common bees, which purſue and kill, even thoſe which have not undergone their transformations, and which are ſtill in the ſtate of worm or nymph. It is believed, with ſome probability, that the reaſon of ſo extraordinary a change in their behaviour, is, that the mother bee, ceaſing then to lay eggs, till the following ſpring, the drones become uſeleſs, and the common bees diſpatch them, to ſave their proviſion of honey.

Page 133, l. 14.

The reſpect they ſhow their dead. It is much more natural to believe, that the bees do not carry their dead out of the hives, for any other reaſon, than to be rid of the putrid ſmell which the carcaſes would occaſion; and it is probably, likewiſe for the ſame reaſon, that they cover with wax thoſe animals which die in their hives, and which are too large to be removed.

Page 134, l. 21.

The art of fixing it. This art is not difficult, when the object is merely to fix the threads to places within the ſpider's reach. But, how does it contrive to fix them on places, which one would think it could not eaſily come at? How, for inſtance, does it fix them to the top of two large trees, whoſe branches do not touch? or to two bodies, ſeparated by a rivulet? This queſtion would perhaps embarraſs a philoſopher, but it is by no means difficult to a ſpider: in this caſe, it has recourſe to a very ſimple and natural expedient. It ſuſpends itſelf to the end of a thread, and draws with its feet, from the extremity of its abdomen, ſeveral long threads, which it allows to be carried away by the wind; theſe threads which are ſtill connected with its trunk, adhere to the bodies they meet with; and thus, having encountered another tree, or the other bank of a rivulet, they ſerve for a bridge to the ſpider, in order to tranſport itſelf, and to fix the thread to which it was ſuſpended.

Page 134, l. 27.

In the catching of other inſects. This is not the only uſe which ſpiders make of their webs. I have already ſaid, that they make coques of them round their eggs. But a much more ſingular uſe, which ſome ſorts of ſpiders turn them

to

to, is, that they make a ſort of carriages of them, in which they make long journies, and tranſport themſelves from one region to another. We often ſee, when the ſky is clear, at certain ſeaſons of the year, quantities of groſs filaments, and pieces of the webs of thoſe inſects: if theſe are examined, we will always find ſpiders in them, which have contrived this method of flying without wings, and of tranſporting themſelves eaſily to another climate.

PAGE 139, l. *laſt.*

Deſtitute of all ſenſes but feeling. The author certainly does not recollect, that as all inſects eat, at leaſt during a certain period of their exiſtence, and that as they do not eat, indifferently, every ſort of food, but attach themſelves ſolely to a particular kind, it is evident, they muſt all have the ſenſe of taſte, to diſcern what is fit for their purpoſe.

PAGE 140, l. 16.

I know none that have ears. It cannot be doubted, that thoſe inſects, on which Nature hath beſtowed a kind of voice, or to ſpeak more properly, the faculty of forming certain ſounds, as the crickets, the graſshoppers, ſome beetles, &c. muſt alſo have received the ſenſe of hearing, to perceive thoſe ſounds. We do not obſerve in them, it is true, any external ear; but we cannot infer, for that reaſon, that they have none. They may be diſguiſed and rendered obſcure, by their form and ſituation, Animals, whoſe voice is not produced by the throat, whoſe reſpiration is performed through the thorax, the ſides, or the abdomen, ſome of which have their eyes on the back, and the genital organs at the head, animals of this kind, may well have the ears in a place, where we would leaſt expect to find them. The uſes of all the parts in inſects, are not known to us; perhaps, there may be among thoſe we are ignorant of, ſome which are given to them for the purpoſe of receiving the impreſſion of ſounds. Still leſs can we ſay, that inſects have no internal ear. This organ, if they poſſeſs it, muſt in them be ſo ſmall and delicate, that though it were before our eyes, we might even find it impoſſible to diſcern it.—We are not, therefore, ſo well acquainted with the anatomy of inſects, as to take upon us to aſſert, that they are deprived of the organ of hearing, and ſtill leſs ought we to maintain, that they hear, without being poſſeſſed of that organ.

*The late Professor Fabricius discovered the ears of insects. He published an account, with figures of those organs in the crab and lobster, in the New Copenhagen Transactions, Vol. II. p. 375. This eminent entomologist found the external orifice of the organ in these animals, to be placed between the long and short antennæ; the cochlea, &c. being lodged in the upper part of what Linnæus calls the thorax; near the base of the serrated projection at its apex.

PAGE 141, l. 18.

Their trunk and their palpi. If the palpi of insects be the organ of any sense known to us, we would rather suppose them to be the organ of smell, than of taste. Without, however, attempting to decide on this point, I shall only remark, that it seems to be by their means, that insects distinguish the quality of their food. Those which have these parts, never fail, before they begin to eat any thing, to feel it, as it were with their palpi, and if the substance does not please them, they abandon it, without touching it with their teeth, a circumstance, which pretty clearly proves, that, by the mere application of those palpi, they are able to know, what sorts of food are useful, and what improper for them.

PAGE 141, l. 31.

Some prefer the blood of man, others of quadrupeds. There are even some, whose delicacy goes still farther, and which will not touch the blood of certain persons, while they continually attack that of others. This is known to be the case with gnats and fleas. As to the last, it cannot be said, that the skin of certain persons is too hard for them to penetrate, since they are able to pierce the skin of quadrupeds, which is certainly much stronger.

PAGE 145, l. 14.

Some change their skin four times a year. As the author is speaking in this place, of caterpillars, before they change into butterflies, &c. it is proper to observe, that his expression is not very accurate, when he says, they change their skin four times in a year. From this, one might be led to infer, that they live more than a year, although it be a general rule, and one, to which I have hitherto found only a single exception, that all caterpillars finish that stage of their existence, in less than a year; there are even some that accomplish it, in less than a month. He would, therefore, have

expressed

expreſſed himſelf better, had he ſaid, ſimply, that they change their ſkin four times; but that, however, would not have been a general caſe, for I have already ſaid, elſewhere, that I have known ſome caterpillars change their ſkin, ſeven, and even nine times, before entering into the chryſalis ſtate.

PAGE 146, l. 6.

Others have the head very large. The proportion between the head and the body, is not always the ſame, in the ſame inſect; in thoſe that have it horny, it is ſmall, when they are about to change their ſkin, and increaſes in ſize, every time the change is made. The reaſon is evident; the horny ſhell prevents it from growing, while the body increaſes in bulk, and thus its ſize, in proportion to the body, continually diminiſhes. When inſects prepare to diveſt themſelves of their ſkin, the ſubſtance of the head, in a great number of them, retires within the neck, and into the firſt articulation: there, having generally no hard or horny matter to confine it, it extends and enlarges, and when the animal has quitted its old ſkin, we are ſurpriſed to ſee it with a head twice as large as it had before. And, as the inſect neither eats nor grows while its head is forming, we may obſerve this ſingularity with regard to it, that the body and the head have alternately their turn for enlarging; that, while the body does not increaſe, the head grows, and that, when the head does not grow, the body grows.

PAGE 146, l. 12.

It is not eaſy to diſcover the head in ſome inſects. There are even ſome ſpecies, that can draw the head entirely within the body, ſo that no part whatever of it appears: ſuch are thoſe larvæ which change into flies, and alſo, ſnails and ſlugs. It is ſingular, that in theſe inſects, the head has no determinate ſhape, and in this particular, they differ from all other animals.

PAGE 146, l. 18.

Winged inſects, which have feet. All winged inſects, hitherto diſcovered, have feet, without exception.

PAGE 146, l. 30.

Ichneumons, that breed in the body of the caterpillar with ſeventy-two folds. Ichneumons cannot be properly diſcrimi-

nated by the caterpillars they iſſue from; becauſe, the ſame ichneumon will often lay its eggs in the body of different ſorts of caterpillars, and becauſe one kind of caterpillar often nouriſhes various ſpecies of ichneumon. Beſides the inſect, of which the author here ſpeaks, does not appear to me to be a real caterpillar, as caterpillars have only twelve rings, which are ſeldom ſubdivided into folds, and thoſe which are ſo ſubdivided, have only a few. It is more probable, therefore, that the animal mentioned, is a pſeudo-caterpillar, that is, an animal, which in general reſembles a caterpillar, but which has more than ſixteen feet, and which naturally changes into a fly with four wings, (Tenthredo.) Among theſe, there are many, whoſe body, although divided into twelve ſegments, is ſo wrinkled on the upper ſide, that perhaps one might count ſeventy-two folds in the whole length of the back. In ſuch a caſe, the fly in queſtion, might perhaps not be an ichneumon, but the natural fly of a pſeudo-caterpillar, and then it would be well deſigned. I am not certain, that what the Germans call Schlupff-weſpen, always ſignifies ichneumon, though tranſlated ſo.

Page 147, l. 15.

The extremity of the antennæ is in ſome thickeſt. The figure of the antennæ, in inſects, is too varied for us to enter into a detail of the varieties here. The lepidopteræ alone, have furniſhed Reaumur with ſix general claſſes, which may all be again ſubdivided.—See Reaumur Vol. I. Page 1. Mem. 5.

Page 148, l. 5.

With their antennæ they clean their eyes. The antennæ of the greater part of inſects, are not ſufficiently flexible for the purpoſe of conveniently cleaning their eyes; they more frequently employ their feet. But many, when they are at reſt, partly cover the eyes with the antennæ, and thus, they ſerve inſtead of eye-lids, which all inſects want.

Page 148, l. 11.

Antennæ are likewiſe the organs of ſmell.

*Though the eyes of the large blue flies be covered with turpentine, it does not hinder them from ſmelling out putrid ſubſtances at a diſtance, but they could not do this, if the proboſcis were laid over with the ſame liquor.

That the antennæ are the organs of ſmell, is not at all certain, and it would require experiments, much more deciſive,

tive, than that of the author, mentioned in the foregoing note, to eſtabliſh it. For, ſuppoſing that his experiment ſhould ſucceed, we might ſtill ſay, that, if the fly, whoſe eyes were laid over with turpentine, found out the putreſcent ſubſtance, it was, becauſe the turpentine, which is a tranſparent liquor, did not prevent its ſeeing it; and if it did not alight on the putreſcent ſubſtance, when its proboſcis was laid over with the ſame liquor, what does that prove with regard to the antennæ? Beſides, it is not eaſy to conceive, how the ſtrong and penetrating ſmell of the turpentine, which in this experiment, muſt have ſurrounded and covered almoſt the whole head of the fly, could allow it to diſtinguiſh the ſmell of a carcaſe, at a conſiderable diſtance.

PAGE 148, l. 34.

The eyes of ſome muſcæ, like gold. I do not know what ſpecies of muſca the author here means; but there are ſome ſpecies of ſmall dragon-flies, whoſe eyes are more than hemiſpherical, and which have the colour and all the brilliancy of the pureſt gold.

PAGE 149, l. *firſt*.

As a diamond, expoſed to the rays of the ſun. I have never yet found an inſect, whoſe eyes in bright day, were ſo brilliant; but I know ſome, whoſe eyes in the night, ſhine brighter than thoſe of cats.

PAGE 149, l. 3.

Totally diſappear, after the death of the inſect. This is not ſurpriſing; the cornea of the eyes of inſects is hard, and tranſparent as glaſs; it is only the coloured humours, under that cornea, which give them the colours which we admire in them. Theſe humours, corrupting after the death of the inſect, and being dried up, loſe their colour, and give the whole eye that faded appearance which they aſſume.

That inſects of different ſpecies ſhould have eyes differently coloured, is not at all ſurpriſing; but, that the ſame inſect ſhould have eyes of various colours, is what perhaps, we would not expect to find. An ephemera, however, furniſhes an example of this; it has four reticular eyes, while inſects, in general, have only two; and of theſe reticular eyes, two are brown, and the two others of a citron-colour. See Reaumur, Vol. IV. Part I. Mem. 6.

PAGE

Page 149, l. 14.

**Some insects have five eyes.* The Abbé Catalan, in his observations on the eyes of flies, has remarked, that besides the two large reticular eyes; which they have at the sides of the head, and which have the red colour of morocco leather, they have besides three others on the forehead. To try whether these saw equally well with both these sorts of eyes, he covered the reticular eyes of a fly with fluid pitch, leaving the three other eyes open; he put it then under a glass, where it ran up and down, without striking against any object, and when he lifted the glass, it flew away towards the window. He took another fly, and covered with pitch, the three eyes on the forehead, leaving the reticular eyes open, and he found, that this likewise saw equally well. Lastly, he took a third fly, covered both the reticular and the forehead-eyes with the pitch; but this fly seemed to be quite blind, it walked slowly under the glass, and when that was removed, it groped its way, like a person blind, and did not venture to fly.—See Act. Erudit. anno 1682.

Page 149, l. 17.

Spiders generally have eight eyes. Tarantulas, that dangerous sort of spider, have likewise eight eyes: but differ from the generality of spiders, which, according to M. Homberg, Mem. de l'Acad. R. des Scien. 1707, have black eyes, these having them white, approaching to a yellow gold colour, and shining in the dark. And what is still much more singular, that academician affirms, that the cornea is moist and tender, and shrivels up after their death; a circumstance, of which I do not know another instance among insects with feet, the cornea of these being always hard and horny.

Page 149, l. 23.

Consisting of a vast number of small hexagons. These eyes are generally called reticular eyes. I have always found them, in every sort of winged insect which I have examined, but I have never, or very rarely found them in such insects, as had not undergone their last change.

Page 150, l. 17.

Palpi, by which they examine their food. I have already, in

in the preceeding chapter, given my reaſons, for thinking, that theſe palpi may be the organs of ſmell, in inſects.

PAGE 151, l. 22.

It is with the mandibulæ they ſeize their prey. Among the different uſes of theſe pincers, that of ſerving as a mouth to inſects, which have none, is the moſt ſingular. See what I have ſaid above, on this ſubject, page 372, under the words, *Have received a ſort of pump.*

PAGE 151, l. 28.

Have at the mouth, a ſort of claws. See the Note on the words, *It is found at the mouth*, page 326, where we have given the deſcription of a ſingular maſk, which ſome inſects have before the mouth, and which they uſe as claws or talons, for ſeizing their prey.

PAGE 152, l. *firſt.*

**Some that can extend or draw it in.* The trunk of common flies can be thruſt out, or drawn in at pleaſure. It very much reſembles the proboſcis of an elephant, except, that it is thicker at the extremity, than in the middle, has a ſort of rim round it, and is garniſhed with hairs.

PAGE 152, l. 2.

The lepidopteræ roll it up. See a curious and particular deſcription of the tongues of the lepidopteræ, in Reaumur, Vol. I. Part I. Mem 5. and of the trunks of gnats, in Vol. IV. Part II. Mem. 13.

*This member in butterflies, has ſomething wonderful in it, and we may venture to ſay, that it is one of the maſter-pieces of the Creator. When it is extended, its length exceeds that of the animal itſelf, and it rolls and unrolls it, with inconceivable velocity. Nature has perhaps given it ſo long a tongue, that it might the more eaſily penetrate to the bottom of flowers, and extract their honey. If it were obliged to thruſt down its head, it might injure its eyes, which are not provided with eye-lids.

*It has been obſerved, that when the tongue of lepidopterous inſects is cut off, it retains a degree of irritability, for a conſiderable time afterwards.

PAGE 152, l. 25.

There follows the thorax. On the ſubject of this part of the

the body of insects; I cannot help remarking, that, though winged insects generally have but one thorax, and that it appears as singular to say, that an animal has two, as it would be to say, that it had two heads, or two bodies, the case, however, of an insect having two thoraxes, is not without example. M. de Reaumur has given us one instance in the fly that comes from the Formicaleo (Myrmeleon Formicarium): a fly, otherwise of a very singular kind, will afford us another. This animal, which I have never found, but in its last and perfect form, has really two thoraxes, very distinct, and separated from each other, by a very visible intersection. From its head, to the extremity of its abdomen, it is a full inch in length; its head, thoraxes, and almost its whole body, are black; its antennæ, which have ten articulations, and its feet, are of a greyish brown colour, except, that its last pair have an incrassated part, which is black; this pair, as well as the second, is attached to the second thorax, and the first supports the first pair of feet. One would take this insect at first, for a large ichneumon, which it resembles, in the form of its head, its feet and body.— But, it is essentially different, in having but two wings, which are larger, broader, and stronger, than those of the common ichneumons. But, what still more distinguishes it, and even renders its class very doubtful, is, that its second thorax is covered with a case of two pieces, hard, and of a dirty brown colour, like those which cover the wings of beetles. This case is only two lines long, and ends where the abdomen begins. It does not appear, that it can serve as in beetles, to enclose the wings, for these are four times longer than the cases, and there are no folds to be seen at their nerves nor articulations, by which they can be folded, so as to be concealed below these cases. Besides, it is under the cases that the wings are attached to the second thorax. Such is the figure of this animal, whose uncommon shape, and its being perhaps unknown, appeared to me, to deserve a particular description.

* It is very probable, that Lyonet has deceived himself with regard to this insect, which appears from his description, to be nothing but a Staphilinus or Necydalis, except in the circumstance of the wings never being folded up within the elytra; and here some accident must have occurred, to lead him into the mistake.

PAGE 153, l. 11.

Furnished with a margin. One of the most essential distinctions between these articulations, is, that some are placed end to end, while others inclose the extremity of the one next them, and slip into one another, as in a groove.

PAGE 153, l. 15.

All caterpillars have ten. They have twelve, counting the posterior extremity, and the first articulation, which the author seems to take for the neck. It is not so easy to explain how M. Andri was led into the mistake, as he counts only seven articulations in the silk-worm, sixteen, and even more in other caterpillars, and twelve in the ant. One would not have expected to find such an assertion in a book written expressly on insects. If his observations on the worms which infest the human intestines, were all in the same taste, his work would little deserve those encomiums which fill the first pages of his book.—See *Andri de la Gener. des vers, dans le corps de l' homme.*

PAGE 153, l. 18.

A larva of a Tenthredo. Those which we have called pseudo-caterpillars, as I think I have already said, have properly but twelve articulations, like true caterpillars. But there are some of those pseudo-caterpillars, which have their articulations subdivided into others, and these M. Lesser seems to have counted as distinct segments.

PAGE 154, l. 4.

The insect called Hippocampus. I have shewn elsewhere, that this animal is not an insect, but a true fish.

PAGE 154, l. 7.

Furnished with a small bag. This has the appearance of a bag only on paper. Frisch gives the name of bag to the extremity of the abdomen, in the insects of the Genus, Sphex, Lin. which have that part of a different colour from the rest: and this, because the colour which distinguishes it, makes it appear, as if it were inclosed in a bag. He gives these insects the name of sack-wespen, or wasps with a bag, to distinguish them from other wasps. It is from him that

Leſſer gives the name of bag, to the poſterior extremity of theſe inſects.

Page 155, l. 8.

The papillæ, from which they draw their threads. Spiders, which M. Leſſer has here in view, have each, according to M. Reaumur, (Mem. de l'Academie de Sciences, 1713,) ſix of theſe papillæ. The extremity of a papilla, in one of the houſe ſpiders, when magnified by the microſcope, appeared divided into an infinity of protuberances, ſmaller, but diſpoſed much in the ſame way, with thoſe that occupy the cornea in the eyes of Muſcæ. Each protuberance or convexity, in this caſe, undoubtedly affords a different thread, or rather, it is probable, that each concavity, ſituated between thoſe convexities, is pierced by a hole, through which the thread iſſues; the ſmall elevations ſeem intended to prevent the threads from joining at their exit. Theſe convexities are not ſo apparent, at the extremities of the papillæ, in garden ſpiders; but there is obſervable, a quantity of ſmall hairs, which probably ſerve the ſame purpoſe, that is, to ſeparate the threads from one another. However this may be, it is certain, that of every teat in a ſpider, threads may be drawn from a thouſand different places; ſo that the ſpider, having ſix of theſe papillæ, has holes to allow a paſſage to ſix thouſand different threads; and what is ſtill more wonderful, theſe threads are already formed, when they arrive at the papillæ, and they have each its own little tract, which conducts it thither. Theſe little tracts are, moreover, incloſed in different fleſhy tubes, which Reaumur ſuppoſes to be equal in number to the papillæ; theſe tubes terminate in winding veſſels, which he calls the great reſervoirs, and of which there are three on each ſide of the ſpider; theſe three unite at a very long branch, which takes a ſerpentine courſe,and after having formed ſeveral turns, each terminates in a veſſel which has the form of a tear of glaſs. Theſe two veſſels, are thoſe which Reaumur conſiders as the original ſources of the threads of ſpiders. Who could have imagined, that the formation of a ſpider's web required ſuch apparatus; or, that the papillæ of ſo vile an animal, was an object ſo worthy of admiration!

Page 155, l. 16.

A ſort of horns. It is ſaid, that in ſome inſects, as for inſtance,

inſtance, in the aphides, theſe horns are the organs of reſpiration.

PAGE 156, l. 3.

**Forwards under the belly.* As for inſtance, in the large reddiſh yellow ſpider, of which Friſch gives the hiſtory, (Aranea diadema.)—The Author.

It appears from this note that the author is ſpeaking of a particular ſpecies of ſpider. That ſpecies I have not had an opportunity of obſerving, but I have examined ſeveral other ſpecies, and I can affirm, that I have found the male organs placed at the head, while thoſe of the females were ſituated in the belly, preciſely in the ſpot where Friſch places thoſe of the male in queſtion. This would make me ſuſpect that the ſpider he mentions was a female, and the more as he repreſents its body as exceedingly large, a property peculiar to the females of ſpiders, for I have always found the males with an abdomen proportionally ſlender. Lyonet.

PAGE 156, l. 5.

Situated as in the males. This is in general the caſe, but there are however ſome exceptions. The inſtance of the ſpider mentioned in the preceding note is ſufficient to ſhew, that there are inſects whoſe male organs are placed differently from thoſe of the female.

PAGE 156, l. 10.

Some likewiſe have a sting at the extremity. The author underſtands here by the word ſting, not only that part which ſerves as an inſtrument of offence; but alſo that organ which ſerves as a conduit to their eggs when they introduce them into bodies which for that purpoſe they need to pierce. As thoſe parts are very different, it would be better to diſtinguiſh them by different names; that which ſerves them for introducing their eggs, might be called the tail, (Cauda Lin.) and the term ſting (Aculeus Lin.) appropriated to that which is properly ſo.

PAGE 157, l. 3.

Often more than half an inch in length. There are ichneumons in my collection with tails near two inches long, and ſurpaſſing greatly the length of the inſect itſelf. It is ſel-

dom that the tails of insects, which have any, terminate in a pointed knob. The greater part of them have a cylindrical form without any sensible thickness at the extremity.

PAGE 157, l. 25.

* *Those which deposite their eggs in other insects.* Ichneumons deposite their eggs in the bodies of caterpillars where they are hatched, and produce larvæ; these larvæ maintain themselves there, and feed on the substance of the caterpillars which thereby become weak and languishing. When the larvæ have attained their size, and neither find room nor food in the caterpillar, they make their way through its skin and then the caterpillar dies.

PAGE 157, l. 31.

They use it as a pike or lance. The sting is by no means an organ peculiar to the male insects. Among bees for instance the males have no sting; it is the same with wasps. The females only and the neuters are provided with it.

PAGE 158, l. *first*.

Which they use as a spiracle. There are some aquatic insects which can elongate their tails to an astonishing degree. The rat-tailed larvæ are well known, not indeed so much by that name given them by Reaumur, as by the form of their tail. This organ, though longer than the animal, is only the case of another tail longer still, which is capable of great contraction, and enters into the body of the larva. This last tail is the organ of its respiration. It raises it to the surface of the water to take in air, and while itself remains at the bottom, it can send this tail to the surface tho' the water should be nearly five inches deep; so that it can extend its tail nearly five inches, a very considerable length for an animal only seven or eight lines long. See Reaumur, TOM. IV. and Scottish Register, VOL. II.

PAGE 158, l. 12.

* *Larvæ that have their feet on the back.* This is an observation of M. de Reaumur, as may be seen in the Mem. of the Royal Academy of Sciences, 1714, P. 103, and Frisch, P. II. N. 7. The author.

I am not surprised that the author should advance so positively that there is a particular class of insects both aqua-

tic

tic and terrestrial, which before their transformation have their feet on the back; but which are no sooner divested of their skin, and begin to fly, than they have their feet under the belly. Frisch in the place here quoted, expresses himself on this head in a manner so decisive, that it would appear incredulity to hesitate a moment in believing that there were such insects. These are his words when speaking of the insect we shall immediately mention. The "greatest singularity in this larva is, that it has its six legs "on its back. M. de Reaumur, in the Memoirs of the "Academy of Sciences, has well described a species of a-"quatic larva, which has likewise its feet on the back; he "says he is uncertain under what division of insects to class "it. For my part, I make a particular class of these "insects, whether aquatic or terrestrial, that is, of those "insects which before their transformation, have their "feet upon the back. To this class, belongs the insect des-"cribed by Reaumur, and the beetle in question. &c." Would not one imagine from this passage that Frisch had discovered a great number of insects of this kind, and that it only remained to class them? He cites however only these two species, and I do not remember that there is ano-ther instance in his work. I do not mean to deny that there may perhaps be insects, that have at first their feet upon the back, and which, after their transformation, have them then under the belly; yet I think the circumstance very un-likely, and it has never hitherto occurred to me. It ap-pears however, that Mr Frisch has been rather precipitate in establishing a class for such. M. de Reaumur does not affirm as a well ascertained fact, that the singular insect which he describes in the Memoirs of the Academy, has ac-tually its feet on its back. He says only that it has them on the back, or on the opposite side to its belly, supposing the belly to be on that side where the mouth and the anus are situated, and towards which the head generally inclines. So that if this insect had accidentally its head and the anus placed a little differently from what is the ordinary position in insects, a circumstance not altogether singular, it might, notwithstanding these appearances to the contrary, still have its feet on the side opposite to the back. Besides, neither Reaumur nor Frisch had seen the transformation of this a-nimal, at least they do not mention their having seen it; and

it

If they did not see it, how could Frisch class this insect with those which, after their transformation, have the legs under the belly? How could he even affirm that it is among the number of those that undergo transformation? I come now to his own insect, which is the single one we can begin with in establishing this new class. I have examined this insect which is one of the largest found in this country, and consequently so much the easier examined. (It is the Dytiscus piceus Lin.) I have fed it, and followed it in its transformations from the egg to its becoming the perfect insect, which Frisch could not do, as he did not know its proper food; and the fruit I have reaped from my attention is, not only the discovery of many remarkable properties, but the privilege of affirming positively, and with more confidence than Frisch does the contrary, that the insect in question has, in every stage of its life, the legs placed in the under side like all other insects. It would be sufficient to look at it swimming to be convinced of this; but I have much more certain proofs; I have made the insects change into nymphs under my eye, and I have seen them very distinctly in the act of withdrawing their feet from the crustaceous cover under which they performed the office of feet, while the insects were still in a state of larva. This is not all; as I have brought up many, it has sometimes happened that when they were preparing themselves to appear in the state of nymph, some of them have not been able to extricate their head from the old cranium: and therefore their skin burst on different parts of their body, without their being able to disengage themselves from the fragments. I have then taken them, and have removed the skin from the place opposite to that where the feet of the insect were placed; here according to Frisch, the limbs of the nymph ought necessarily to have been found, but I never found there any thing resembling them; afterwards I disengaged the head from the old cranium, but when I attempted to remove the skin from the place where the feet were situated in its larva state, I never could succeed, the feet of the nymph being there entangled in the crustaceous cover of those of the insect; that cover served them as a sheath, and to it they were attached so strongly that I could not disengage them without their breaking. I had thus a nymph which had its six feet broken off, and of which the part torn away, remained in the crustaceous cover of the feet of the insect. Can there be a stronger proof that this animal in its creeping state, has its feet precisely

precisely in the same place they are situated in, while in the nymph state, and consequently also in its state of perfect insect, that is, under the belly, and by no means on the back, as Frisch asserts?

The circumstance that may have led him into this error, is, that this animal has not its head inclined towards the belly, as is the case with almost all other insects, but that it carries it a little bending backwards. This situation of the head seems to have been given it to enable it the more commodiously to eat those small snails which are its common food. These snails are found among the Ducks-meat which swims on the surface of the water. In order to seize these, the reversed situation of the head makes it easy for them when they are below. After laying hold of them, the shell is to be broken in order to get at the animal; this cannot be done but by resting the snail upon something to keep it fast; the feet of the larva are not adapted to this purpose, they are too weak, too distant, and have neither claws nor nails; accordingly, in this case they are useless. It is to their back that they have recourse; it serves them for a fixed point, on which to break the shell, and as a table on which to eat the snail enclosed in it. When they have seized it with their teeth, they fold themselves back, they raise the back a little, and on it, they lay down the snail. In this attitude their head naturally a little inclined backwards, bears more perpendicularly on the snail, and makes it more easy for them to break the shell, and to swallow the animal, than if their head were inclined downwards.

There is another circumstance that may have misled Frisch, which is, that the insect in question, when it prepares to change into a nymph, does not bend itself forwards, as do most terrestrial insects, but backwards, like some other aquatic insects, of which perhaps Frisch had never observed the transformations; and in the opinion that all insects, when they dispose themselves for their change, appear incurvated towards the belly, the contrary attitude in which he had seen the animal in question may have contributed to make him take for the belly of the insect, what was really its back.

PAGE 158, l. 18.

Such are all caterpillars. Caterpillars properly so called, and

and which have this name in contra-distinction to other larvæ, and to those called Geometræ, have generally sixteen feet; six anterior, eight intermediate, and two posterior. The posterior and the intermediate, properly speaking, have no articulation. They are capable of elongation, contraction and flexure in every direction, without having any apparent joint. Being purely membraneous, those fixed fulcra, and [that stiffness of parts necessary to] the existence of a true articulation are wanting. As to the anterior feet, they terminate, it is true, in a pointed hook: but that hook does not constitute the foot, and when it is examined minutely, there are distinguishable three articulations at least, small indeed, but very distinct. If there be insects whose feet have but one articulation, the singular water-Tipula I have mentioned above, Page 315, may be ranked in the number.

PAGE 158, l. 33.

**The fore legs in some being the longest.* Plin. Lib. xi. CAP. 48. Insectorum pedes primi longiores duros habentibus oculos, ut subinde pedibus eos tergeant, ceu notamus in muscis.

If that observation be true, the flies in the country of Pliny, and the other insects with hard lenticular eyes must be made differently from those in this country; for here we hardly see one which has not the anterior pair shorter than the intermediate or posterior.

PAGE. 159. l. 19.

* *Some have a sort of cup at the knee joint.* The larger Dytisci have within this cup at the knee, a muscle which they can retract. When they have applied this cup against any thing, it connects itself therewith so closely, that no air can enter within it, and then by contracting the muscle, the void which is then formed, renders the adhesion the stronger. It is by this organ that the insect attaches itself closely to the female, to its prey, or to any other object it pleases. The *Author*.

The cup here mentioned, is situated on the first pair of feet. The males of many species of Dytisci are furnished with it, but I have never observed it on the feet of the females. This affords a presumption that it is bestowed on the males to enable them to fasten themselves more securely

to

to the females at the time of coupling; and accordingly they do not fail to employ it for this purpose.

Page 160, l. 3.

* *Some employ their feet in cleaning.* Thus Aristotle says:—De partib. Animal. L. iv. Cap. 6. Pedes priores nonnulla ex iis longiores ideo habent, ut quoniam propter oculorum duritiem non exquisite cernant, cruribus iis longioribus abstergeant incidentem molestiam atque arceant &c. See too Pliny L. xi. Cap. 48.

I have already remarked above on the passage of Pliny here refered to, that almost all the insects of this country have the anterior pair of feet shorter than the rest.

Page 160, l. 6.

Those which dig in the earth. The strength which nature hath given to the feet of many sorts of insects which use them for this purpose, is astonishing when we consider their minuteness; in order to be convinced of this, we have only to close our hand upon some of those beetles that dig in the earth, and we will be surprized at the efforts we must make to keep them.

* The earth is the abode of the Gryllo-talpa, (Gryllus Gr) Its feet accordingly are formed for digging; they are not less hard than the claw of a crab, and the first articulation is round at the extremity, and serrated; with such feet he can dig on each side, above and below him. A species of bastard wasp (Sphex), of the largest size, deposits its eggs in holes made in the earth or in sand. For this purpose it generally throws with its anterior pair of feet, the earth or sand below its belly, nearly as dogs do when they dig for moles. When the heap of earth or sand grows too large it gets above it, and works as before with so much dispatch that in a moment the whole is removed; thus it prevents the earth from falling back, and filling up the hole.

Page 160, l. 11.

* *Some use them for seizing their prey.* The anterior pair of feet, in the cimices aquatici, are of no use in walking. They are used as antennæ, and as claws for seizing and holding their prey. They have along their feet a groove in which the foot or the claw may be lodged from the articulation to the extremity. This groove resembles that which receives the blade

of a pocket knife, and is given them, lest the claw should be clogged or hurt by any accident.

PAGE 160, l. 12.

* *By the structure of the legs, the species distinguishable.* Flies that prey on one another, have at the last articulation of the foot, long and strong nails. The end of the leg is forked, and each nail occupies an extremity. This is common to all the flies which are carnivorous, and is a mark by which they may be known, as we know hawks and vultures by their talons.

PAGE 161, l. 18.

There is great diversity in the figure of the farinaceous wings. Although the figure of the wings in lepidopterous insects varies exceedingly, yet that which their superior wings are most inclined to, is the scalene triangle of which the long side answers to the exterior margin of the wing and the short side to the interior margin. The mixt or curved lines which form the margins are generally very irregular, and the exterior margin seldom forms an arch as Jonston has though fit to represent it The under wings of moths, are often made in the form of a fan, and, are folded nearly in the same manner.

PAGE 161, l. 26.

The margin of the wings is often indented. When the wings of the lepidopterous insects are indented, the dents are found always at the apex of the wing, rarely on the interior margin. I know only one or two sorts of butterflies which have any thing like it on the exterior margin of the upper wings.

PAGE 161, l. 31.

Ornamented with fine fringes. This ornament nature has given almost to the whole tribe of Phalænas The apex and the interior margin of their wings are adorned with fringes, but their upper wings have none at the exterior margin.

PAGE 162, l. *first.*

In the form of very delicate feathers. It has been already remarked above, that the name of scales or plates would agree better with the coloured dust which adorns the wings of

of butterflies than that of feathers. But there is a particular genus of the Lepidopteræ, which Mr Leffer does not mention, whofe wings may be faid to be compofed of feathers, or at leaft of bearded ftems which very nearly refemble them. (Phalænæ Alucitæ Lin.) Thefe wings are not made like thofe of ordinary Lepidopteræ, of a tranfparent membrane covered with a coloured duft which renders them opake; thefe barbed and divided ftems themfelves form the wing, juft as the feathers form the wings of birds; but with this difference however, that the feathers of the wings in thefe Phalænæ are not laid over one another, and that being very large there are but few of them in each wing.

Page 162, l. 27.

Some with the figure of an arrow. All thefe reprefentations which are generally very imperfect, merit but little attention; they are only fit to amufe the vulgar who are eafily perfuaded that there muft be fome concealed fenfe in the cafual refemblance of a letter, or of fome emblematic figure.

Page 163, l. 14.

Lines like the furrows of a ploughed field. The furrows we obferve in the elytra of fome beetles, are often characteriftic marks of the female; they are not always found in the male.

Page 164, l. 11.

Hairs which change when the infect grows old. It is chiefly when larvæ ceafe to eat, and prepare themfelves for undergoing a change, that there fometimes happen very confiderable variations in their hairs. I know fome caterpillars with hairs naturally white, which at that time change from white to black, in the fpace of an hour or two.

Page 165, l. 2.

The hairs are weapons of defence. The hairs of infects are generally ftiffer, and more brittle than thofe of other animals, which renders the wound they give fo troublefome. Being fo slender and fine, they infinuate themfelves into the pores of the fkin, where they break, and the broken part penetrates ftill further, the more it is touched. This is the

cause of that itching, and those small pustules which have made these caterpillars without any reason be supposed poisonous. This has already been observed by M. de Reaumur, and I have experienced it myself in repeated instances. Among the great number of smooth caterpillars of everykind which I have had occasion to handle, not one of them ever did me the smallest harm. But as to the hairy caterpillars, they have often affected me with pain even without having touched them, and merely by opening with my fingers, the coques where they had left their hairs.

Page 166, l. 19.

The skin covers many parts worthy of attention. Although from the manner in which this Chapter begins, we are led to expect an anatomical description of the principal parts which compose the bodies of insects, we must not expect to find in it what will satisfy the curiosity of an intelligent anatomist. In order to give some just idea of the marvellous in the internal structure of these little animals, it would be necessary to enter into a detail which, alone, would furnish materials for more than one volume, and which could not be interesting to any but connoisseurs. General reflections, such as those to which Mr Lesser has been here obliged to confine himself, give but a very imperfect idea of the subject. No author has treated it in such a masterly and satisfactory way as Swammerdam has done. His Biblia Naturæ, which is almost entirely a collection of anatomical facts, shews clearly that there are not fewer parts required in the formation of an insect, than in the bodies of the larger animals; and, what supposes a much more admirable mechanism in the former is, that many of the internal parts in a great number of species, after having subsisted for a considerable time in one state, afterwards change their form, their functions, and their nature, and adapt themselves to those new uses which result from the different transformations which insects undergo.

Page 166, l. *last*.

* *It may well receive the name of flesh.* This we must observe, contrary to Aristotle, who seems to have thought that insects have no flesh properly speaking, but merely a substance analogous to it, when he says; H. A. L. iv. Cap. 7. Quod autem pro carne in iis habetur, id nec testam imitatur, neque quod in testaceis genus carnis continetur;

tur; sed mediam quandam inter hæc refert naturam. *The author.*

If the substance which composes the bodies of some insects be possessed of such a degree of consistence as to deserve the name of flesh, however improperly applied, that of which the bodies of the greatest part of them are formed, especially before their last change, is so soft or rather fluid, that the name of viscid humour seems much more applicable to it. And accordingly M. Lesser in the foregoing note, might well have spared Aristotle for his remark on the subject.

Page 167, l. 29.

More elaboration than can be performed in a body so small. I doubt if this reason will satisfy the intelligent reader. The great apparatus observable in the internal structure of insects, of which however we can only see the most obvious and coarsest parts, the exceeding minuteness of some, several thousands of which united would not equal in size a grain of sand, and in which we must notwithstanding suppose parts analogous to those of the largest insects, shew evidently that it is not beyond the power of matter when in the hands of the divine Creator, to form in an insect however small, all the vessels necessary for performing the requisite digestions and filtrations in order to convert the aliments into blood. It seems, on the contrary, still more evident, that if insects have not blood similar to ours, it is because that blood would be too gross to pass through vessels so delicate as theirs, and therefore it is necessary they should be provided for this purpose with fluids much more subtilised than those which enter into the composition of our blood, of which a single globule is sometimes larger than the whole body of some of these animals. But without deciding positively on the matter, we may at least consider as a certain fact, that if insects are not furnished with blood similar to ours, they have however fluids that perform the same functions; and we cannot doubt that these fluids circulate in their veins when we attend to what passes in plants, and the larger animals; considering especially that there are insects in which we can discover pretty convincing proofs of this circulation. Such for instance are fleas: for when we examine their legs in a microscope, we distinctly see vessels which after having

ing proceeded a certain length, return in another direction, towards the trunk of the body from which they set off.

PAGE 168, l. *first*.

This glutinous quality of the humours. I allow that the tenacity of the humours in insects may contribute to their tenacity of life; but what I believe to contribute still more to this quality is the circmstance of their vital principle, at least that of the far greater part of them, not residing solely in the head, but being dispersed over their whole frame. I have seen a caterpillar continue to creep about for some days after its head had been cut off. I have seen the body of the common earth-worm, which some aquatic insect had reduced to one third of its length, live in the water for the space of a week after being thus maimed, and at both ends. I have seen motion in the abdomen of a wasp three days after its separation from the thorax. If the vital principle of insects resided only in the head, we could conceive that the tenacity of their humours might contribute to detain life for a certain time in that head and the part of the trunk attached to it: but how could the mere tenacity of the humours preserve life and motion in the other parts, which being then separated from the head, would be deprived of the vital principle, and the influence of the animal spirits? These parts ought immediately to perish; but as they do not, and preserve their activity for a considerable time, it seems natural to conclude that the principle of life and motion does not reside solely in the head, but is distributed over every other part of the body.

This is not all, it may be inferred from some experiments I have made on the animals we have mentioned, that if insects have a soul, this soul is likewise extended over the whole body, so that when the body is divided, it too is divided of course. Every part of these divided animals appears to me capable of exhibiting marks of consciousness and sensation. When I touched the headless caterpillar; it made the same motions which it used to make in the same circumstances before it was maimed, and if I persisted for any time in annoying it, it ran away. The trunk of the earth worm when it seemed perfectly at rest, was no sooner touched than it put itself in motion and made off with expedition. When I held the anterior part of the wasp, it bit into every thing I presented to it, and when

when I touched its trunk, although separated for some days from the head, it immediately put out its sting, and darted it on all sides, and in every direction, as if endeavouring to wound me. Is it not evident that all these different parts of the animals, notwithstanding their separation, had still preserved not only life and motion, but the faculty of receiving impressions from objects, and the desire of self-preservation; each, according to its nature, determining either for flight or resistance? And how is it possible to conceive that each of the parts separated from the same animal could retain that faculty, and that desire, if they had not at the same time preserved the principle in which both reside, that is, the soul? and the soul cannot be found in two separated parts of the same animal without being itself divided. Here then is the soul of insects, at least of some of them, divisible; what a strange paradox!

Perhaps it may be thought, that in order to establish an opinion so singular, more decisive experiments than those I have just related should be made; take then the following, which seem to me unanswerable, and appear to demonstrate that if insects are endowed with a soul, there are some in which that soul is not only divisible, but such as that each of the parts into which it is divided, is sufficient to animate an entire body, and to preserve its life. The first of these experiments is made on that small aquatic animal mentioned above, P. 300, whose body in bulk is about the size of a seed of Dandelion (Hydra polypus.) It is an ascertained fact, that when it is cut in two, or even in three parts, each part becomes an entire animal, which performs its functions as before. My second experiment goes still further; I have several times not only cut in two, but in four, eight, sixteen or more parts, a species of aquatic worm, of a reddish brown colour, about three or four inches long. The greater number of these divided parts, and often the whole of them, have not only preserved sensation and motion, but after ten or twelve days begun to push out at the two extremities, and became in three or four months each an entire animal; so that thus a single worm sometimes furnished me with more than sixteen, which I have moreover caused to multiply in the same way, as often as I pleased After these experiments, it would seem difficult to with-hold our assent to the proposition that there are insects whose soul, if they have one, is divisible and even into a great number of parts, all sufficient

ſufficient for animating a body compleat in its parts and functions: for when we examine theſe two ſorts of animals, we ſee evidently that each is a ſingle inſect, not a concatenation of inſects united end to end, as ſome people aver of the Solitaire; and thus I do not conceive what can be alledged againſt the concluſions which reſult from the facts we have detailed.

PAGE 168, l. 12.

Inſects have an artery. This is the veſſel which it is ſup-ſuppoſed forms the heart of inſects; or if you will, it is a ſtring of hearts running through the whole length of their back. In caterpillars the pulſations begin in it at the poſterior extremity, and go ſucceſſively from articulation to articulation towards the head. M. Reaumur on the ſubject of theſe pulſations mentions a very ſingular fact. He ſays that we may obſerve in chryſalids newly transformed, and ſtill tranſparent, that theſe pulſations change their direction, and that the great artery which, in the caterpillar, puſh the fluid from below towards the head, puſh it in the chryſalis from the head towards the tail, a circumſtance which ſuppoſes that in theſe two ſtates the circulation of the fluid which ſerves the purpoſes of blood proceeds in a quite contrary direction. I regret that I have hitherto neglected to repeat the experiment on chryſalids newly transformed; for although I do not doubt that the fact is ſo in the caterpillars which that illuſtrious author had examined, I have reaſon to believe that either that new motion does not continue for any long time, or that it is not common to all chryſalids. For having found a ſpecies of caterpillar which furniſhed me with, what is very rare, a chryſalis exceedingly tranſparent, and through which I could ſee diſtinctly all the movements of the artery, I took ſome of them a few days after their tranſformation, and ſet myſelf to examine them at different times with the greateſt poſſible attention, and that during the ſpace of ſeveral months, that their transparency laſted; and I always obſerved in them, with the greateſt certainty, that the pulſations of their heart, or if you will, of their great artery, had in no degree changed their direction in the chryſalis; but that they continued during all that time to proceed from the tail towards the head, as they had formerly done in the caterpillar.

PAGE

PAGE 168, l. 23.

* *Some are found to ruminate.* Such are the four species of locusts mentioned in Leviticus, CH. XI, 21 and 22. "Yet these may ye eat of every flying creeping thing that goeth upon all four, which have legs above their feet to leap withal upon the earth. Even those of them you may eat; the locust after his kind, and the bald-locust after his kind, and the beetle after his kind, and the grasshopper after his kind."

I am not sure that there are any insects which ruminate. This is a circumstance which Swammerdam supposes of the grasshoppers, and which Mr Lesser thinks he can prove from Scripture: but in my opinion, the passage proves no such thing. The animals are there distinguished into four classes, *viz.* Quadrupeds, or as the Hebrew text expresses it Beasts, (taking this word in a more extended sense than is generally given to it,) fishes, birds and reptiles or insects. The sovereign legislator indicates, with regard to the two first classes, the characters by which the animals permitted by the law to be eaten were to be known. Those of the first were to be ruminating animals, to have the hoof divided, and the foot cloven. Those of the second class were to have scales and fins. As to the third, the clean beasts are not distinguished from the unclean by any character; but instead of this, the law expressly mentions those birds which were not to be eaten. And as to the fourth class, the law contents itself with forbidding to eat, " every flying thing that goeth upon all-four, having, besides its feet, legs to leap withal;" and it excepts from this general rule only the four sorts of locusts mentioned in the note above. This at least is the sense I would give to this last passage, which is also countenanced by the Hebrew text; for the version of those interpreters is hardly admissible who translate it, some thus, " Yet these may ye eat of every flying creeping thing that goeth upon all four, which have legs above their feet to leap withal;" and others according to the observation of M. de Lesser himself, ' which goeth upon four feet, and which have not legs to leap withall,' But whatever interpretation may be given to the place cited, I do not know how it can follow that the four species of locusts, there allowed to be eaten, were among the number of ruminating animals, or that the bare mention of their four feet, is sufficient to make them be considered

as subjected to the law established before in the same chapter, for animals of the first class, or to infer from the passage that because the law allowed the eating of these locusts that therefore they must ruminate, which seems to me to be the reasoning of our author.

PAGE 169, l. 8.

Is formed of little vesicles. If we are to understand here by lungs, a spongy substance filled with small vesicles, and penetrated in every part by the different vessels which in the inspiration of the larger animals, receive the air by means of the trachea, I doubt much if any such lungs have hitherto been discovered in any insect, and the two vesicles in bees which the author seems to consider as lungs on the authority of Swammerdam are by no means such. The bronchiæ, of which a great number are found dispersed over the whole body in most insects, seem to serve them instead of lungs, and to supply the want of that spongy substance, which has never yet been detected in them.

PAGE 169, l. 14.

In insects it is nothing but skin. We find, it is true, in the bodies of insects a number of vessels which seem to be composed only of a single membrane; but these are not the pulmonary vessels; which as we have said elsewhere are tubes, constantly open, surrounded with a thread closely wound round them, like the slender wire round the bass string of a violin. That thread is easily disengaged from these tracheæ, by passing lightly over them a moistened pencil. Those vessels make a very curious object in the microscope; we are struck with admiration at seeing those branches, which for the most part are incomparably more slender than a hair, and of which there are thousands in the body of a single insect, fabricated with so much art.

PAGE 169, l. 29.

Those of others have five furrows. It is very general with those caterpillars which have a horn on the posterior part, to void those channelled fœces; the furrows are likewise often crossed by intersections which divide these fœces as it were into different rings. The cause of their regular and uncommon form certainly deserves investigation; it seems rather to depend on the muscles of the anus, than on the internal figure of the rectum, which does not seem to be

a

a vessel of sufficient firmness to give such a form to excrement so hard as theirs.

PAGE 174, l. 10.

An ant as big as a middle sized dog. We would have been very much obliged to M. de Busbequius if he had been No. 50.
so kind as to send some of those monstrous ants to Europe. He would have then had the pleasure of delivering naturalists from the repugnance they must feel in believing so extravagant a fact.

PAGE 174, l. 15.

Without the assistance of a microscope. This is not all. There are some which the most excellent microscopes can hardly make visible, as we have already remarked.

PAGE 175, l. 8.

Shine like burning coals.—Besides the insects which shine in the night, such as the glow worm, &c. there is one found in Surinam which deserves to be known on account of its singularity. According to the description which Mad. Merian gives of it, this animal, in its creeping state, seems to have a form approaching that of our small grasshoppers, but is much larger; like them it has a long proboscis by which it sucks the juice from the flowers of the pomegranate, and this proboscis remains with it all its life. After having quitted one skin, it changes its form, and appears under that of a large green fly like our Cicada. Its flight is then very rapid, and the noise it makes with its wings is like the sound of a cymbal. Although according to the ordinary course of nature, an insect, after having acquired wings, undergoes no farther change, yet this one, by the concurring testimony of the Indians which Mad. Merian says she had in part verified by her own experience, undergoes still a last transformation which renders it luminous, and which then procures it the name of the lantern fly. (Fulgora Laternaria Lin.) In this last transformation, besides other inconsiderable changes which happen to its body and wings, there issues, from the forepart of its head, a very long transparent bladder, coloured with reddish and greenish streaks, and which diffuses a light sufficient to enable a person to read pretty small print. This animal, by the description she gives of it, is then about four inches long, and the bladder occupies about a fourth of its whole length. Before

Mad. Merian was acquainted with the luminous quality of this insect, the Indians brought her many of them which she shut up in a large box. Being alarmed one night with a singular noise which she heard in the house, she got up, lighted a candle, and went to see what it was. The noise came from the box; she opened it, and immediately there issued a flame, which encreased her emotion, and made her throw down the box, whence there was now dispersed a new beam of light, as each animal got out of it. We may believe her fear did not long continue, but soon gave place to admiration, and she immediately set herself to regain animals so extraordinary, which had taken advantage of the fear they had occasioned to make their escape.

Page 176, l. *first.*

By the clapping of the wings against one another. A great number of insects make a buzzing with their wings by agitating them without suffering them to touch each other, or even to strike their body. Such are all the flies with two wings which make a noise in flying, and among others the gnats. In this case the sound they excite is formed probably either in the same way with the sound made by a stringed instrument, merely by their vibrations; or it is made by reiterated strokes made on the small scales which some flies have under their wings; or perhaps by the extremely rapid agitation of those two small moveable poisers which the wings of that sort of flies have near their origin. These wings striking against the poisers when agitated may cause this noise, by an effect similar to the sound produced by a cord in vibration, when it meets with any body which touches it without resting on it. An easy experiment may perhaps elucidate the matter; we have only to cut away those small poisers and scales from the large buzzing flies which have them: if, after that operation, they continue still to buzz when they fly, it will be a proof, that the noise proceeds from the mere agitation of the wings. But if, on the contrary, the buzzing ceases, we may then with reason infer, that the poisers and scales concur in producing the noise. For there is little probability that it is formed by them alone; the vibrations of bodies, so short and so delicate, do not appear capable of producing tones so grave; although it is not, however, impossible; considering, that

that the velocity of their agitations does not depend on any thing, perhaps, but the mere will of the animal.

PAGE 176, l. 28.

Discharge a sensible smell. Many species of ichneumons and wood-bugs, have a very disagreeable smell. I have seen larvæ, not so large by half as a bean, and which are of the number of those that change into beetles, which send forth so strong a smell of box-wood, that one could not remain in a room where there were only two or three of them. A kind of large cantharis in this country, smells so strongly of honey, that in the open air, I have sometimes smelt it, at the distance of thirty paces.

PAGE 177, l. 16.

This is a sort of web. We must not think, that, when we see stagnant waters, covered with a green and fibrous pellicle, that this pellicle is always a web, woven by insects. It is generally a species of alga, which grows in still waters, and which is much relished by some small larvæ; perhaps, from their being so often found there, it has been thought, that they made it. At least, I have never found any such pellicle, which could be truly considered as the fabrication of any animal.

PAGE 177, l. *last.*

The appearance proceeds from certain species of butterflies.— It is very common with flies, and with all sorts of moths and butterflies, after having disengaged themselves from their covering, while in the nymph or chrysalis state, and when their wings are unfolded and grown firm, at the moment when they are disposing themselves to take their first flight, to discharge from the extremity of their abdomen, a quantity of superabundant humours, the secretion of which had been made, while they were in the nymph or chrysalis state. These humours have no resemblance to the natural excrements of those insects; they are of different colours, and those which fall from butterflies are often red. Such, for instance, are those of the small thorny caterpillars, which live in society on the nettle. These, and some others, when they are to undergo their changes, leave the plant on which they have fed, and suspend themselves upon walls, when there are any at hand, and from this it has happened, that

that those red spots have been generally found on walls, and were formerly most erroneously considered to be drops from a shower of blood.

PAGE 179, l. 8.

The large reddish yellow spiders. In general, spiders do not live in concord, except when very young. When they are larger, there is no longer any society or union among them, except at the time of coupling. Except at this time, if they are shut up together, they do not spare their own species, but kill one another without mercy: even those which do not eat one another, do so, one would think, out of pure ill-nature.

PAGE 179, l. *penult.*

Entirely deprived of every sort of food. I think I have already observed, that there are caterpillars, which, without being reduced to it by this extremity, eat one another from mere gluttony; but the species are rare, as I have hitherto only met with two kinds.

PAGE 180, l. 9.

It is said, that some insects have an aversion. In Natural History, it is dangerous to admit marvellous facts on mere hear-say; but we must not, on the other hand, reject what is wonderful, because it appears to us improbable: we ought to examine Nature, and attend to the proofs on which the relation is made. If a person, for instance, little versed in the art of making observations, should maintain, that the head, and the tail of a wolf were good for keeping off flies, that crickets kill the cuckoo, and at the same time, do not explain how he has acquired the knowledge, nor by what experiments he has assured himself of the truth of the facts; I am entitled to doubt his assertion, the more, as relations of this kind have the air of fables, and that it is with difficulty we can believe that the head and tail of a wolf should drive away flies, while the flesh of other animals, and according to all appearance, that of the wolf itself, attracts them: we can still less conceive, how a cricket, whose bite is very gentle, and which seems not very capable of high flight, could contrive to kill so large a bird as the cuckoo, whose flight is very rapid, and which continually perches on trees. But if, on the other hand, an author of credit

credit and intelligence, relates to me an extraordinary fact; for instance, that when a crab has lost a limb, another is produced in its place, and informs me, that in order to ascertain the fact, he has shut up, and fed a number of mutilated crabs; that he has examined them with care, and details to me every step in the progress of the growth which these mutilated limbs made, from time to time, till they acquired the intire form and size of the one lost, I ought not to hesitate in believing, on his authority, such a fact, however wonderful and strange it may appear to me; because his integrity persuades me, that he is incapable of willingly imposing on me, and because all the accounts he gives me of his experiments, shew me, that he was not himself deceived.

Of the four examples of antipathy, mentioned by our author, there is only one which can easily be brought to the test of experiment, that is, the antipathy between the toad and the spider. It is believed, almost every where, that when a toad passes under the web of a spider, this latter lets itself down, in order to bite the toad, which, on his part, expects it with open mouth; that, if he catches it, it is lost, if it bites him, he is instantly poisoned, and runs, with all expedition, to eat of a certain herb, which serves as a counter-poison; after which, he returns to the combat, which is accordingly renewed; but that, if he cannot find any of his herb, he immediately swells and bursts in a few seconds. An opinion, so generally received, deserves to be examined; and accordingly, I have often attempted to make the experiment, by obliging a large spider to descend on a toad, or by putting a toad under a spider's web; but none of my attempts have ever succeeded, and none of my animals ever shewed the smallest disposition to a battle. Perhaps the experiment might succeed, if they were inclosed in a glass together: this still remains to be tried: in the mean time, it becomes those only, who have seen the fact, to affirm it as a truth.

Page 180, l. 15.

Some insects are subject to the stone. Of all the insects subject to this disorder, there are none of them whose disease is so useful to us, as those oysters which produce pearls. M. de Reaumur believes, that they are formed in the body of the oyster, by the rupture of those vessels which contain the fluids that serve for the formation of the shell. These fluids

fluids, when extravasated, grow hard, a new fluid succeeds, and, fixing itself around the pearl already begun, it makes a second stratum; that stratum is followed by a third, and thus, the pearl is formed of several concentric strata. What confirms the opinion of this illustrious author, with regard to the formation of pearls, is this; he found that the shell of the Pinna marina is composed of two different substances, the one of the colour of mother of pearl, and the other reddish; and, that the parts of the animal containing pearls, had a reddish or dark colour, according as the part affected corresponded with the dark or reddish part of the shell.—See Mem. de l'Acad. des Scien. 1717.

PAGE 183, l. 6.

Sometimes five and forty thousand animalcula. Some art must have been used to collect together so many animals, in so small a space, either by evaporating or filtrating the water, or in some other way; for it is not probable, that a single drop of water, so small as the size of a millet seed, should naturally contain so many thousands of animated beings. But what will appear still more difficult of belief to many people, is, that it was possible to make a calculation near the truth, of so great a number of animals; for, they were either dead or living at the time they were counted. If they were dead, how could they be discerned? The best microscopes in such a case, do not enable us to distinguish so small an animal, from any other corpuscle which swims in the same fluid. But, if they were alive, how could they be counted, even in the loosest way, considering, that then they must be swarming and struggling for room in so strait a place? The difficulty appears great; but it may be solved, and it may be shown, that there is no impossibility in making a gross calculation. It may be done, for instance, in the following way: I would at first begin, by comparing the diameter of one of those small animals, considering it as spherical, to the axis of a sphere, of the size of a millet seed, and I would see how much the one exceeds the other; now, as spheres are to one another, in the triplicate ratio of their axis, this would inform me at once, how many times the animal is smaller than the sphere I compared it to; then, taking a drop of water, of the size of that sphere, and which swarms with animals, the number of which I wish to ascertain, I would allow it to dry up on the microscope, till

these

these animals were confounded in a single mass; I would then, of that mass, form in my own mind, a spherical volume, and by comparing, however loosely, this volume, with that of a millet seed, I would know the proportion in size, which these two spherical masses bear to each other, which would lead me to ascertain the number of the animalcula which the drop I was examining contained. Such calculations, as they depend on very nice observations, and in which it is difficult to determine things with precision, cannot be made with very great accuracy; but, if it is difficult to attain the perfect truth, we, however, would not be very far wrong, and this method is sufficient for common purposes.

Page 185, l. 2.

Red, like polished copper. There are found in this country, flies of this kind, proceeding from a white maggot, with a head of a changeable shape, which spins a coque, so thin, so close, and so transparent, that one would take it for a single membrane. It is impossible to conceive more vivid, or more beautiful colours, than the golden and fiery colours which sparkle on the body of the fly of this maggot. I have never found any insect which came near it, except a certain beetle, proceeding from a white larva with six feet, and a brown head, which lives on the white nettle. The colour of this beetle, differs from that of the fly, only in this, that the gold prevails more in the beetle; in other respects, the lustre of both is so great, that I believe it perfectly inimitable by art.

Page 185, l. *last.*

Some have the whiteness of the diamond. The tubercles on the caterpillar of the Phalæna caja, which the author cites in a note, as an example, are black. Its stigmata only are white; but, it is a whiteness which resembles milk more than the diamond. However, it is certain, that, notwithstanding the general disposition to consider all caterpillars as ugly and disgusting animals, there is not, except butterflies, any other kind of insect, and perhaps even any other animal, which affords so many instances of all the beautiful colours. Gold, silver, and mother of pearl, are the only ones wanting: nor can we say positively, that gold is wanting, for I know a caterpillar, which has, on the upper side of each articulation, four small yellowish spots, placed in a square form, which acquire the colour and splendor of gold,

as soon as the caterpillar ceases to eat, and prepares to change into a chrysalis

PAGE 186, l. 10.

Mirror points. The butterflies, adorned with these spots, are called in French, peacock-butterflies. M. de Reaumur names their spots, eye-spots. The Dutch call these butterflies, in their language, peacock's eyes, and peacock's tail; because their spots resemble much those spots like eyes, that adorn the tails of these birds. In other respects, the criticism of Lesser is not very interesting to Naturalists; it is of little consequence what names are given to things, provided people are agreed concerning the things designed by these names: and it is even better, to preserve improper names already received, than to give more suitable ones, which are new; because, science is interested, that each thing have a single name, that the memory of those who learn, may not be uselessly burdened: which is but too much the case already in botany.

PAGE 186, l. 24.

As if they were the work of a painter. Of all known animals, there are not any, which, for the beauty and agreeable disposition of their colours, can be compared to butterflies. There are some, which cannot be seen, without admiration. And, as if it was not enough, that Nature had lavished on them, whatever is most beautiful and perfect of this kind, there are, besides, some of them, where gold, silver, and mother of pearl, appear with wonderful splendor. Altho' Europe produces many butterflies of extraordinary beauty, they are, in general, however, much inferior to those which come to us from the Indies: besides the advantage which these last have, of being, for the most part, larger than ours, it would seem, that the brilliance of their colours increases in proportion to the heat of the climate, of which they are natives.

PAGE 187, l. 3.

Or rather, those feathers. It has been said above, that thy are not feathers, but scales, or small laminæ.

PAGE 191, l. 7.

Regaled with the dish the Magistrates of Frankfort. Locusts must formerly have been a food, known in Judea, and the

the neighbouring countries; since Moses permitted the Jews to eat four sorts of them, as the author has observed above, and the Scripture informs us, that John the Baptist lived on locusts and wild honey.

Besides, it is not in the Indies alone, that insects are considered by the inhabitants, as a delicate food. Every body knows, with what pleasure Europeans eat the sea-eggs, crabs, lobsters, oysters, muscles, and other shell-fish. Snails that feed on vines, and even some slugs, are not rejected. I do not mention the thighs of frogs, vipers or turtle, because, for the reasons I have given above, I do not consider them as insects.

Page 193, l. 4.

**The silk-worm draws from its body, threads.* Boyle, in his Essay on the *Subtility of Effluviums*, Ch. II. mentions a lady, who, having taken the trouble to undo the coque of a silk-worm, found, according to her calculation, that the thread was about 300 English miles in length.—The Author.

There has certainly been some error here. I have often measured the thread which forms the coque of the silk worm, and I have never in general, found it longer than from 700 to 900 feet. Supposing, with the author of the *Spectacle de la Nature*, who cites Boyle, that the thread of a coque is 930 feet long, and weighs two grains and a half; I find, that it would require a thread, 3,428,352 feet long, to make a pound of silk, from which it would follow, supposing these feet standard, that a pound of silk would extend to 228 French leagues, supposing each league 15,000 feet long, or 3000 geometrical paces.

Page 194, l. 19.

So far as to make a suit. I do not believe, that M. Bon carried the matter quite so far: but we are informed, in the Memoirs of the Royal Academy of Sciences, 1710, that he presented to the Academy, the year before, stockings and gloves, made of the webs of spiders.

This led the Assembly, to recommend to M. de Reaumur, and another member, to follow out the discoveries of M. Bon. Reaumur did so, and the following is, in general, the result of his experiments. He found, that the webs of spiders, were by no means proper for use, because the thread of them is too delicate, requiring ninety to make a thread, equal in strength to that spun by the silk-worm, and

and about 18,000 of them, to compoſe a thread fit for ſewing, as ſtrong as the threads uſed for that purpoſe, made of ſilk. There remained, therefore, nothing but the coques which they weave round their eggs, from which any utility could be expected: he examined theſe, and found, that none but thoſe of ſuch ſpiders as weave webs, with rays proceeding from a centre, round which runs a ſpiral thread, could be of any uſe, the coques of the other kinds furniſhing but little thread, or that thread not poſſeſſing the neceſſary qualities. It was then to be diſcovered, if ſilk could be made from thoſe coques, as cheap as common ſilk; or if dearer, it would alſo be more beautiful. The firſt queſtion was ſoon decided. Although M. Reaumur found in earth-worms, and in the ſoft ſubſtance of young feathers, a food agreeable to ſpiders, and eaſily procured, and that thus, the difficulty of providing them with a ſufficiency of flies was obviated, he met with another, which he could not remove, and that was, the mutual hatred they bear to one another, which precluded every attempt to breed them together. It would therefore have been neceſſary to rear them ſeparately, which could not have been done without infinite trouble, and conſequently without great expence, and conſidering, that he found the threads of the coques of ſpiders to be five times more ſlender than thoſe of the ſilk-worm, and that it required twelve times more ſpiders than ſilk-worms to furniſh the ſame quantity of ſilk, inſomuch, that to procure a ſingle pound of ſpider-ſilk, he needed almoſt eight and twenty thouſand coques, which could not be had without breeding a much greater number of ſpiders, as the females only make them, he was convinced, that ſpider-ſilk would coſt infinitely more than common ſilk. It only remained, then, to know whether it would be more beautiful; and this, M. de Reaumur was perſuaded would not be the caſe; on the contrary, he found that it had leſs luſtre, and the reaſon he gives for this, is, that the threads which compoſe the ſilk of ſpiders, are more delicate, and more criſped, than thoſe of the ſilk-worm.

From all this, we learn, that it is not by rearing ſpiders, that we can expect to turn this ſilk to advantage.—— The only means, perhaps, by which we might profit by their labours, would be, by obſerving the time when they fly in the air, ſuſpended by their threads, or when they are preparing for ſuch expeditions, and then to ſend country people into the fields, to collect thoſe threads with rakes.

There

There are certainly times, when in a few hours, a large quantity might be gathered. I have often seen the meadows quite covered with it. Perhaps, by carding and spinning this thread in the manner of flax, it might be turned to some use; at any rate, it would cost very little to try the experiment.

PAGE 195, l. 26.

A manufacture established. However industrious the Dutch may be, in what relates to trade and commerce, they have never yet attempted the breeding of silk-worms in Holland; those who rear them there, doing it only for their own amusement. There is but a single individual in these Provinces, who has carried it to any considerable degree. It succeeded so well with him, that it is said, the silk-worm alone has enabled him to build and maintain a very fine country seat, in the neighbourhood of Utrecht. The machine he erected there, and which is moved by the fall of a very small rill of water, deserves to be seen. It turns six thousand bobbins, and winds as many coques at the same time.

PAGE 196, l. 14.

If one should calculate. This calculation, if I am not mistaken, would, in a dozen of years, amount to five hundred and thirty one thousand, four hundred, and forty one hives, supposing that no hives had perished during the time, and that each had regularly produced two swarms a year.

PAGE 196, l. 25.

The cochineal is a small worm. The cochineal is not a small worm, which produces a scarabæus; it is one of those animals, which M. de Reaumur calls Pro-Gall-insects, that is to say, insects which differ from those he calls Gall-insects, only in that these last have the body very smooth, when they are large; while the others preserve those wrinkles or articulations, which give them more the appearance of insects, and make them less like galls, than what he calls gall-insects.

The gall-insect, in other respects, and the pro-gall-insects are both animals with six feet, and there are many species of them. The largest known, hardly attains the size of a middling pea. While they are very small, they are active, and run about with great vivacity, but the females, when they

they become larger, fix themſelves to ſome part of a plant or tree, the ſubſtance of which they ſuck; there they afterwards attain a conſiderable bulk, and with it, loſe the power of changing place, and even all the external figure of an animal, aſſuming that, nearly of a gall, into which one would think they were metamorphoſed. It is in this motionleſs and immoveable ſtate, that they receive the intercourſe of the male, which is now transformed into a very ſmall fly, is an active animal, and is, in no reſpect, like the females. Theſe, after the embraces of the male, without changing place, lay their eggs in great numbers, which they paſs from the extremity of their abdomen, and lodge under their belly: they now die, and their body, which ſtill remains fixed to the ſame ſpot, ſerves as a cover to the eggs, to preſerve them from the injuries of the air, till the young ones are hatched, and iſſue from this cadaverous protection, to tranſport themſelves elſewhere.

PAGE 197, l. 2.

Suck the fine red fruit. The juice of the fruit of the Cactus opuntia, is, it is true, very red, and is ſo indeed, to ſuch a degree, that it changes the colour of the urine of perſons who have eaten of it, into a deep red, like blood: but, it is not the fruit which the cochineal ſucks; it is the leaves of the plant which are green, and have no red juice in them. It is probable, that, as the ſap of this plant undergoes in the fruit, that alteration which gives it the red colour, it likewiſe undergoes a ſimilar alteration in the body of the cochineal.

M. de Reaumur, in the ſecond Memoir of his 4th volume already cited, enters into a very curious diſcuſſion on the cochineal and the manner of gathering it. What he there ſays, deſerves the more conſideration. that it is founded on authentic documents, judicially proved, and elucidated by his own obſervations. He concludes, by ſhewing the importance of theſe inſects as an article of revenue. and for this purpoſe, he quotes a Diſſertation of M. Neufville the Dutch envoy, who proves, that 700,000 pounds weight of fine cochineal, are every year imported into Europe, and at leaſt 180,000 pounds weight of an inferior ſort. The firſt ſells for ten florins, ten ſous; and the other, for thirty Dutch ſous a pound, the whole amounting together to 7,410,000 florins, Dutch money, or upwards of L. 650,000 ſterling, which is conſequently

quently the value of the European importation of that article in a year. Could it be ſuppoſed, that the gathering of animals ſo ſmall, would become ſo conſiderable an article of commerce?

PAGE 197, l. 12.

An inſect which yields a very fine carmine. It is this inſect, and not the cochineal, as M. Leſſer ſeems to think, that the French call *graine d'Ecarlatte.* It is likewiſe named *Kermes* of Poland.

It is ſaid, that the cochineal affords a carmine, at leaſt as beautiful as that of this Kermes.

The little veſicles, attached to the root of the Polygonum minus cocciferum, are neither excreſcences nor coques, they are real animals, of the kind which Reaumur calls pro-gall-inſects. They are of two ſizes; the one as large as a pepper-corn; the other of the ſize of a millet-ſeed; the firſt are the females, which undergo no transformations; the others are the males, and change into winged inſects; but not into ichneumons. Their hiſtory at length, may be ſeen in Breynius, and in Reaumur, Vol. IV.

PAGE 197, l. 27.

This animal is found in ſmall veſicles. This animal, which is called Kermes, is of Reaumur's Genus of gall-inſects: they are not found in veſicles; but theſe veſicles are the animal itſelf, which has aſſumed that form. It would appear, that prior to the obſervations of Meſſ. Garidel and Emeric, it had generally been conſidered as a true gall. M. Geoffroy, in the Memoirs of the Royal Academy of Sciences for 1714, conſiders it as ſuch, but M. de Reaumur does not heſitate, from the obſervations juſt mentioned, to pronounce it a gall-inſect. In his further remarks, M. Geoffroy ſays, that this Kermes is but little uſed in dying, and that, were it not for its medical properties, it would perhaps be altogether neglected, as are many other animal ſubſtances formerly uſed in dying purple, ſuch as the purple of the antients, which Reaumur has obſerved and deſcribed, the inſects at the root of the Pimpernell, thoſe of the Lentiſcus, the Parietaria, the Plantane, and of the Knawel, which are found in great quantities in Poland, and which ſome call Poliſh cochineal. He ſays, that the abundance and the beauty of the true cochineal, has rendered uſeleſs, all thoſe other matters uſed in dying red.

PAGE

PAGE 198, l. 21.

Wax, used in dying red. Sealing wax is still made of it, and from this, probably comes the name of *lac*, which the Dutch give to this wax.

PAGE 199, l. 28.

The features, so striking. It is not surprising, that similar portraits of wax should be like, for the features are moulded on the very face of the person they represent.

PAGE 200, l. 3.

**When gnats bite keenly.* The cause of this phenomenon seems to be, that the heat, which generally precedes rain, makes them dry, and then, impelled by thirst, they seek to gorge themselves with the blood of men or beasts.

PAGE 200, l. 3.

**When butterflies do not rise high.* When it is about to rain, the air is then heavily loaded with vapours; which obliges butterflies, whose wings are very delicate, to fly lower than ordinary.

PAGE 200, l. 4.

When worms come out from their holes. There is seen, pretty frequently, on the tail of the larger slugs, when they creep, either a particle of earth, or a bit of a blade of grass, and it is generally said, that the first indicates rain, and the latter is a sign of fair weather. This is a prognostic which I have not myself examined, and therefore, do not answer for the truth of it.

PAGE 200, *title of the chapter.*

Theology. The purpose of the author, in the whole of his book, is to draw from the knowledge of insects, practical rules, useful in a theological view. The end of this chapter, to judge of it by the title, would seem to be the same: it differs, however, in this, that M. Lesser here proposes to shew, in what insects have contributed to the rites of ceremonial worship, and how they may become an instrument of chastisement, in the hand of God. Here it is God, who makes use of insects to raise us to himself; there we, from the consideration of them, endeavour to employ them for the same purpose.

PAGE

PAGE 202, *title of the chapter*.

In jurisprudence. This chapter is somewhat different from what its title bears; it treats much less of the customs and usefulness of insects in jurisprudence, than of the customs and usefulness of jurisprudence in relation to insects: and, as the author appears, in this respect, to depart from the general tendency of his work, I shall dispense with making those observations on it, which my profession would enable me to do. But I cannot forbear remarking by the way, that, if the Pithyocampæ, mentioned by the author, are really true caterpillars of the Pine, as the Greek word signifies, there would then be a species of poisonous caterpillars, which is not hitherto known, those which the common people believe to be venomous, not being really so, as I have already mentioned.

PAGE 204, l. 12.

Man could hardly imitate. We have, however, found means to accomplish this; and we now make by art, skeletons of leaves, much more perfect than those made by insects.

PAGE 206, l. *last*.

Applications of living worms. These applications are likewise a specific remedy in wounds, in order to remove, dangerous inflammation. A creditable person assured me, that by this means he preserved the finger of a certain patient. The inflammation had proceeded to such a length, that it was resolved, if no favourable alteration happened in four-and-twenty hours, to amputate the finger. The person, from whom I have the fact, came in the mean time, and advised the application of living worms, to which the patient having consented, the diseased part was surrounded with them, and in the morning, the inflammation had totally disappeared, and was soon followed by a successful cure.

Among those insects without feet, which are useful in medicine, we may likewise place the snail and the slug.— The latter is supposed to be a successful remedy in Hernia, and in Consumptions. It is known, that the snail is excellent in the gravel, and that it makes one of the principal ingredients, in that admirable medicine, invented by Miss Stephens, for dissolving the stone, which procured her five

thousand pounds from the British Parliament, on making it public.

PAGE 207, l. 11.

Inclosed in a nut-shell. If medicines, applied in this way, ever effect a cure, it must surely be, rather by acting on the imagination than on the body. The same may be said of that cure for the cramp, which is, to carry in one's pocket, certain galls which grow on thistles. At any rate, if this last were a good one, we would be indebted for it to insects, as those galls are produced by the puncture of a fly, which, laying its eggs in the stalk of that plant, occasions the growth of a gall, which serves as a lodging-place, and at the same time, as food for the larvæ to be excluded from the eggs.

PAGE 208, l. 4.

The powder of burnt caterpillars. If the powder of every different sort of caterpillar produces this effect, it is probable, that it is not by any particular styptic virtue found in the whole tribe of caterpillars, but merely, because every powder, which is not soluble in fluids, and which does not provoke sneezing, is effectual in stopping an hæmorrhage at the nose, caused by the rupture of some small vessel; for by absorbing the thinner part of the blood, the more gross part must instantly become fixed, and, together with the powder, stop up the orifice of the vein from which it issued What prevents me from attributing this effect to any other quality to be found in pulverised caterpillars, is, that these animals, being often of a very different, and even quite contrary nature to one another, as appears from the opposite qualities of the food they live on, it is not very probable, that they can all have the same astringent properties.

PAGE 209, l. 32.

The cochineal insects. M. Lesser here ranks the cochineal among the beetles; this is an error, into which others have fallen before him. The male of the cochineal is a fly, the female has no wings.——See its description above, in the Note on the words, *The cochineal is a small worm*, p. 421.

PAGE

PAGE 210, l. 18.

Cantharides are rarely taken internally. They become fatal when taken in a large dose. I knew a person, who, having taken, by mistake, a portion of cantharides, which had been ordered for him as a plaister, was poisoned; every thing in the power of medicine was done, and his life was saved; but he lost his reason.

PAGE 211, l. 25.

Used in perfumery. Among insects, where only a part are furnished with wings, used in medicine, we may likewise place the *Kermes*, from which is drawn that so much esteemed confection, called, the *Alkermes*. The same insect likewise enters into the composition of the confection called *Hyacinth*. It fortifies the fœtus, and is one of the best cordials, according to the testimony of the Royal Society of Sciences at Montpelier.

PAGE 212, l. 18.

Devours the entrails of certain insects. The number of insects which are preyed upon by other insects, is not confined to the few species mentioned in this place by the author. The greater part of the weakest, at least in certain periods of their life, are devoured by the stronger. To see the war they carry on, a person would say, that they were born merely for the purposes of destruction. The carnage is chiefly dreadful among the aquatic tribe. There is hardly one of these, that does not prey on some insects smaller than itself; these feed on others, which in their turn, eat those that are smaller still. We find some, which do not spare their own species, and which even seem to prefer them. What a confusion in Nature! But, it is a confusion, necessary to maintain an order the most essential; that of keeping insects in equilibrium, and preventing those which multiply most, from laying the world in ruins, by their superabundance.

PAGE 212, l. 27.

The favourite food of the tench. If the species of fishes, which eat insects, or the species of insects that serve for food to fishes, were confined to the small number mentioned here by the author, it would be a very trifling matter. All sorts of river-fish, hitherto known, eat insects; and perhaps,

perhaps, there is not any ſort of worm or fly which they do not reliſh: ſo that, whoever would enumerate, either the one or the other, would perhaps be right, in naming the whole at once.

PAGE 214, l. 14.

The young armadillos. The armadillo is a ſpecies of Indian lizard, to which the Spaniards give this name, becauſe it is armed with very ſtrong ſcales.

*Lyonet is miſtaken here. The armadillo is not a lizard; it has indeed ſomewhat the habit of a lizard, and is covered, inſtead of hair, with an oſſeous cruſt, interſected in ſuch a manner, as to reſemble plates or ſcales; but, in every other character, it is a true quadruped; and ſtands in the claſs Mammalia of Linnæus's Syſtem, under the name of Daſypus.

PAGE 214, l. 24.

For this purpoſe, ſeek the neſts of waſps. If it is for honey, that foxes ſeek the neſts of waſps, they are very ill adviſed, for they will find none there. Let us rather believe, that it is to eat their brood; if there is really any truth in what Elian relates.—De Animal. L. IV. C. 39.

PAGE 215, l. 12.

Bears, when troubled with indigeſtion. When we read of circumſtances ſo ſingular, we are vexed, that the authors who relate them, are never at pains to inform us, by what means they came to the knowledge of thoſe circumſtances. Had they been pleaſed to give themſelves this trouble, they would thereby have prevented all thoſe objections which naturally occur, to render the truth of their relations doubtful. When we read, for inſtance, what is here related of the bear, it is natural to enquire, in what country he is ſo unſuſpicious as to allow his conduct to be ſo narrowly inſpected? by what marks is he known to be ſick? how is he ſuppoſed to be troubled with indigeſtion? if it is with honey that he anoints his tongue, how does he find it ſo conveniently? is there any country, where wild bees do not take care to put their hives out of the reach of injury? how does he preſerve himſelf from being ſtung? All theſe queſtions, which we do not fail to aſk ourſelves, and to which we cannot get an anſwer, incline us often to reject as fabulous

fabulous, those relations, which we might have perhaps believed, had the authors who relate them, been careful to anticipate those objections which, they might have foreseen, would be made to them.

Page 216, l. 11.

And for the use of man. Is not man rather too vain, in believing, that every thing was made for his use? It would not, perhaps, be very difficult to humble his pride a little in this respect, and to shew him, that he flatters himself greatly too much; but this would lead us from our subject.

Page 221, l. 15.

Who can defend himself against their attacks?

Insectum petulans, proterva musca;
Harpyaque, famelicoque milvo;
Et rapax magis et magis gulosa;
Et pudens minus et minus modesta:
Sanguisuga minor, volans hirudo,
Fumosæ hospita concolor culinæ,
Vermis filia, vermiumque mater:
Tunc cum pedibus tuis, scelesta,
Imbutis scabie atque purulentis;
Illo cum ore tuo fimetum olente,
Regales petis, inquinasque mensas;
Nec repulsa fugis, sed usque et usque
Ad prædam revolas; licet minetur
Myrteo puer increpans flagello,
Nec caudam volucris times superbæ,
Nec stili exitium ferentis ictus.

Page 221, l. *penult.*

Pour in myriads. A very remarkable instance of this is found in the Military History of Charles XII. of Sweden, T. IV. The historian, relating how incommoded that unfortunate prince was in Bessarabia, by locusts, expresses himself in these words: "A frightful swarm of locusts generally arose every day before noon, from the side next the sea; at first in small numbers, but afterwards in crowds that darkened the air, and made it so thick and gloomy, that in the whole extent of the plain, the sun seemed to be totally eclipsed. These insects did not fly low and close on the ground, but nearly about the height we generally "see

" see swallows occupying, till they found a field, on which " they could descend. We often found them on the roads, " whence they rose with a sound like that of a hurricane. " They then came down upon us like a deluge, alighted on " the same plain where we were, and without seeming to " dread being trampled to death by our horses, they rose " from the ground, and so covered our faces and whole bo- " dy, that we could not see before us, till we had got out of " the place where they had stopt. Wherever these locusts " settled, they made the most dreadful ravages, devouring " the grass to the very roots, and leaving a country, for- " merly covered with the most beautiful verdure, nothing " but a dry and dreary desert. It would be difficult to " conceive, how so small an animal could pass the sea, if " experience had not too often convinced the unhappy na- " tives of the truth of it: for, after having passed a small " arm of the Euxine sea, from the neighbouring islands or " countries, these insects continue to traverse wide provin- " ces, where they devour every thing that comes in their " way, even to the very doors of the houses."

Page 222, l. 27.

Red larvæ. I am not acquainted with these red larvæ, except a kind of red caterpillar, very thick, (the caterpillar of the Phalæna Cossus,) which the author does not mention, though it is the insect that commits the greatest ravages in the trunks of trees. The very short legs of this caterpillar, and the form of its head, which approaches to that of some larvæ which produce beetles, might have made M. Lesser mistake it for one of those larvæ.

Page 224, l. 4.

After having touched the common nettle. There is a kind of insects called sea nettles, (Medusa) which it is said, have been thus named, because, when touched, they occasion an itching, similar to that produced by the common nettle.— M. de Reaumur, who examined several species of these animals, and who gives a very curious description of them, in the Memoirs of the Academy for 1710, found no such quality in them. Hence we may infer, that if there are any of them who possess it, there are some of them who do not; or if they all possess it, they have it not at all times.

PAGE 224. l. 11.

It does not suffer the less. What renders the sting of bees, of wasps, and especially of hornets, so painful, is not so much the wound they make, as the venom which they insinuate into it; and, as the source of this is soon exhausted, M. Reaumur found, that the first sting of a wasp is the most painful; that the second is much less so than the first, and the third still less than the second; so that after the third, they are become almost entirely harmless, at least, till a new poison has had time to supply the place of the first.

PAGE 224, l. 26.

They thrust in their head, as far as the neck. In this country we have an insect, flat and round, which does the same thing, and which is probably a sort of tick, (Acarus) I have sometimes found them upon me, after returning home from the pursuit of other insects. This animal insinuates its head into the skin, without our perceiving it, and so gorges itself with blood, that from flat, as it was before, it becomes round, and as large as a pea. The first time I perceived it, I supposed that some singular excrescence had been formed on my skin; but, after having well examined it, I saw that it was some animal. On endeavouring to rub it off, I found that I could not. It held too firmly, and it was not without some difficulty, that I at last broke it off, and for fear of an abscess, I was obliged to make an incision into the skin, in order to extract that part of the animal which remained there.

PAGE 226, l. 7.

That the air is filled. This doctrine is surely very curious; it deserves to occupy the place of that of acids and alkalis, with which we seem now to be sufficiently disgusted. Undoubtedly, there could not be found an easier or more convenient means of enabling ignorant people to account for all diseases, than by attributing them to the inspiration of invisible germs. It is worthy, in this respect, to go hand in hand with the doctrine of Sturmius on generation. And as one discovery generally begets others, I do not despair of one day seeing the air become the vehicle of an infinity of different matters. How easy, for instance, would it be, to embellish the system of germs we are talking of, by making the air team with the souls of all the animals that have lived,

ved, or that are to live? These souls, transported hither and thither by the agitation of the air, could not but encounter the germs which it is said to be full of; they would intimately unite with these germs, by some attractive force, which it is easy to suppose; after which, they would enter, along with the germs, into our bodies, where they would produce animated fœtuses; and thus, here is one of the greatest mysteries of generation explained in the easiest manner possible: but, as to its being the most satisfactory— I leave it to Sturmius.

PAGE 230, l. 2.

Not to yield to more probable reasons. To the supposition here made by our author, there arises a difficulty. If small flies have produced the worms he talks of, we would ask, how they could arrive at the size of a quill, or to the length of four inches. The maggots of those flies, which lay their eggs in putrid animal substances, are well known: they are short, and small in proportion to the flies that breed them. They have no external resemblance to those here mentioned, and experience has not yet shewn us, that a difference of food, or a greater degree of heat change the form of an animal, and make it grow incomparably beyond its natural size.

PAGE 230, l. 12.

These worms are of such extraordinary minuteness. It does not appear to me necessary, to suppose the air of marshy places, filled with invisible insects, in order to account for its insalubrity. The exhalations it is loaded with, are of themselves, a cause more than sufficient. We know the effect of malignant vapours; experience shews, that they sometimes kill more rapidly than the sword; and shall we doubt, that air, infected by the putrid exhalations of a marsh, cannot of itself produce disease? Neither is it a very constant rule that those diseases appear only in the summer, and that they disappear in autumn; the contrary is true in Zeeland; the air is never more unwholesome in that country, than in the fall of the year.

PAGE 231, l. 17.

These worms are generated by a species of ichneumon. This is nothing but mere conjecture; the sequel of the chapter shews,

shews, that our author himself considers it as such; though in this passage, he seems to express himself in a manner somewhat too positive.

PAGE 232, l. 21.

**Similar to those that infest the human body.* As men differ, according to climate, in colour, figure, and form, so insects undergo different accidental changes, according to the place they inhabit, and the food they subsist on. M. Godefroy Henry Burgh, took a fly, whose progeny he separated into different colonies, which he fed, some on veal, some on plants, and some on fish. When they became large, those that had fed on the veal, were the largest. May it not be the same with those worms that infest the human body, which are larger or less, according to the place they inhabit, and the aliments they feed on?—The Author.

The answer contained in this note does not remove the difficulty. I allow, that the difference of place may cause some changes in insects; but after all, these changes will not be considerable, and will be hardly greater than those observed in persons of different nations; as we may be convinced of, by comparing insects of the same species, which have been produced in different countries: while the change that takes place here, is a total change, by which, an insect bred in the human body, becomes not only of another colour, but of another form, and of a size, exceeding often a hundred times its natural bulk; a circumstance, which surely no diversity of climate has ever produced in any other animal that we know of. As for the experiment of M. Burgh, whatever diversity he might have found in the flies, whose maggots he fed on different substances, it does not prove that certain aliments will make insects grow much beyond their natural size; all that can be inferred from it is, that when an insect is not provided with the food which is necessary for it, it becomes consumptive, and never arrives at its proper size.

PAGE 234, l. 31.

In a frightful manner. It is plain, that it is not the difference of the poison of the tarantula, which causes the diversity in the extravagant gestures of the people here mentioned, but that this diversity proceeds only from the different dispositions of those who experience its effects, which, like wine, operate differently on different subjects.

It is known that the Tarantula is a species of large spider found in the island of Corsica, and in several places of Italy, and that its name is derived from Tarentum a city of Apulia, which is the country where they are most dangerous, particularly in the plains.

As every thing which regards the effects of the bite of this animal, and the manner in which it is cured, is very singular, the reader will not be displeased to find an abridgement of it here, as it is related in the History of the Royal Academy of Sciences for 1702.

A little time after being bitten by this insect there is felt in the part a very acute pain, and a few hours afterwards there appears a swelling; the person then falls into a profound melancholy, is affected with difficult respiration, weak pulse, imperfect vision, loss of sense and motion, and without assistance death closes the scene.

The assistance which medecine affords, as suggested by reason, consists in dressing the wound, in cordials and sudorifics; but the most effectual and surest assistance, and which reason never could have discovered, is music.

When the bitten person is motionless and to appearance insensible, a musician tries different airs on an instrument, and when he has fallen upon that whose tones and modulation agree with the patient, this latter is seen to make some faint attempts to move; he then follows the time of the music with his fingers, then with his arms, his feet, and afterwards with his whole body. At last he gets up, and begins to dance, his activity and strength gradually increasing. Such a person will dance six hours without intermission. After this he is put to bed, and when he is supposed to be sufficiently recovered from the fatigue of the first dance, he is enticed from his bed by the same air in order to dance again This exercise endures several days, at most six or seven, till the patient is tired, and unable to dance more, which is the signal of the cure being performed; for so long as the poison continues to operate in him, he would dance if they would allow him without intermission till he died. The patient who begins to feel tired regains by little and little his senses, and awakens as it were from a profound sleep, without remembring any thing of what passed in the fit, not even of his dance.

Sometimes the person bit, when the first fit leaves him is perfectly cured; but if he is not, he retains a gloomy melancholy and alienation of mind; he shuns society, goes in

quest

quest of water, and if not prevented, would throw himself into the sea, or the first river. Aversion to black, and blue colours, and a passion for the contrary ones of white, red and green, are likewise singular symptoms of this disease.

If the person does not die, the fit returns about a year after he was bit, and the dance must be begun again. Some have had these periodical returns for twenty or thirty years.

Every different person has his own favourite airs, but in general they are those of a quick and lively movement.

PAGE 235, l. *last.*

That it introduces its eggs. Those who wish to be acquainted with the curious history of this insect may find it at length in Reaumur, TOM. IV. Part 2. Mem. 12. where the author treats of it with his usual accuracy and ability.

PAGE 236, l. 6.

These resemble the seed of a gourd. May not these worms be the same with those described by Reaumur in the Memoir I have just cited. In this case they could not enter with the grass into the stomach of horses; but they would penetrate thither by the anus where the fly which produces them, inserts its eggs. These worms have their segments set with sharp points, so disposed that when their head is turned towards the anterior part of the horse, the points allow them to advance, but prevent them from going back or being pushed out along with the fæces. Thus these insects maintain themselves in the intestines of horses till they are about to change their state; they then turn about and suffer themselves to be excluded in order to go elsewhere to accomplish their metamorphosis.

PAGE 242, l. *first.*

* *Where the vapours are noxious to them.* It is known how far the acid vapours of the Swalbach extend by there not being found any insects or any maggots in cheese there, because flies are wanting to deposite their eggs in it. This last observation shews that the mites of cheese proceed from the eggs of insects. *The Author.*

Provided mites are not oviparous in certain seasons, as I have remarked above that the different sorts of aphides are, I can assert that the mites of cheese are viviparous, having often seen them produce living young: and this being the

case it cannot be said that they proceed from the eggs of insects.

Page 244, l. 4.

It is not possible to exterminate insects. Neither is it necessary. It would be to abuse the power which God has given us over the brutes, were we to attempt so chimerical a project. It is sufficient to endeavour to defend ourselves from them; either by removing them, or by destroying those that attack our persons or our goods; and for this purpose the means are not wanting.

Page 251, l. 34.

* *It is in music alone.* As we know that sound is nothing but a tremulous motion of the air which is communicated to the organ of hearing; as we likewise know that one of two cords in unison being made to vibrate, communicates that vibration to the other, and that the effects of unison and concord, are such as we sometimes feel over the whole body upon hearing certain musical notes; we may therefore maintain that music quickens the motion of the blood, enlivens the spirits, dilates the pores, and thereby opens a passage to those noxious particles which escape by perspiration in dancing.

And as it is still further known, that the composition of the blood, of the nerves and spirits, varies in every individual, as well as in the poison of the Tarantula, we may easily conceive that certain musical tones will agree with certain poisons better than with others, which in order to be put in motion, require a graver or a sharper tone, and thus these tones will excite and expell the spirits constituted in a peculiar way, sooner than if they were not so constituted. Now, when, after several trials, the tone according with the nature of the poison has been found, and that tone repeated often without intermission, it is not surprising that the spirits, being so excited, should enter more and more into the muscles, and force the person to dance, not only in virtue of their own action, but by the assistance of the poison which is then likewise agitated; just as persons in health feel themselves inclined to dance on hearing certain favourite airs. *The author's translation from* SCHEUCHZER.

When in P. 434, I related the effects produced by music on persons bitten by the Tarantula, I did not expect the author was to introduce the subject in this Chapter; however as

as we have both drawn from different sources, what I said will not perhaps be quite useless, and the two details may serve as a commentary on each other. But what appears to me to have most need of illustration is the manner in which the different effects are accounted for. I admire the facility with which M. Scheuchzer conceives the matter. I confess it never would have occurred to me, as it has done to him, to find in the qualities of unison and concord, a reason for deciding positively that music, by acting on the spirits, and on the blood of the patients, should dilate their pores, and allow a free passage to the poison. Still less could I have conceived how a tone more or less sharp should agree with one species of poison, and not with another; and that the instrument tuned to the poison should naturally by its sound awaken the animal spirits, make them pass into the muscles, and enable them, with the assistance of the poison, to make the whole body dance. All this, however easy it may appear to Scheuchzer, has to me something of darkness and mystery that I do not feel myself able to penetrate. I see somewhat more clearly into the explanation given by Mr Geoffroy in the History of the Royal Academy of Sciences for 1702. He conjectures that the poison of the Tarantula, occasions a greater tension of the nerves than is natural to them, or proportioned to their functions. This according to him is the cause of the privation of sense and motion. He next supposes that this tension being equal to that of some string of a musical instrument, puts the nerves in unison with a certain tone, and obliges them to tremble the moment they are struck by the undulations or vibrations natural to this particular tone; that the motion generated in the nerves by this means recalls the spirits which had almost entirely abandoned them, and thus he accounts for this extraordinary musical cure. This explanation, though it may appear easy, has likewise however its difficulties; in the first place it supposes an extraordinary tension of the nerves which puts them in unison with the string of a musical instrument. If this were the fact, then the limbs of the patient who has lost all motion, must be stiff, and in a situation either of contraction or distension according to the equal or unequal action of the contrary muscles. Now I do not know that the patient is ever represented in such a state of rigidity. Besides, if it is by the effect of the unison or concord between the tone of the instrument

ſtrument and the nerves of the patient, that the limbs reſume their motions, there would not I think, be any neceſſity for ſearching out a particular air; it would only be neceſſary to tune the inſtrument to that pitch which ſhould put it in uniſon or at leaſt in concord with the nerves; but of this we are not informed that the muſician ever thinks. Moreover it appears ſomething ſtrange that ſo many nerves of different ſize and length could without deſign be found ſtretched in ſuch a manner as to form concords, or what is ſtill more ſingular, and even in ſome degree impoſſible, become in uniſon with the tone of the inſtrument made uſe of. Laſtly if the ſpirits have almoſt entirely abandoned theſe nerves, as Mr Geoffroy ſuppoſes, I do not ſee how he can at the ſame time ſuppoſe that theſe nerves ſhould be ſtretched beyond their natural tenſion; for according to the moſt generally received opinion, it is by the influence of the ſpirits that the nerves are ſtretched. All theſe difficulties, which I ſtate only to give an opportunity to the favourers of Mr Geoffroy's hypotheſis to anſwer them, do not prevent me however, from conſidering that hypotheſis as very ingenious and even probable, at leaſt till a better one ſhall be diſcovered.

PAGE 253, l. *laſt*.

That the firſt of theſe inſects foretokens war. According to this fine diſcovery we ought to have regularly every year, in the firſt place famine, and then war; for every gall begins by containing a worm, and afterwards a fly, which then laying its eggs in the nerve of a leaf, certainly generates new galls, always prognoſticating new diſaſters. There is nothing but the plague which theſe galls ſeldom or rather never threaten us with; for if a ſpider be found in a gall it is merely by accident, and even then, as galls are not the natural abode of ſpiders, they muſt have a hole in them.

PAGE 259, l. 31.

Marvellous adventures. This was the diſpoſition of the greater part of the Rabbis. They took pleaſure in loading their writings with ſtories devoid of probability. This has made authors imagine that theſe ſtories were only meant as bold figures and allegorical fables, under which the moſt important truths were concealed. It was probably this turn for the marvellous, which made the Romans take the Jews

for

for a very credulous nation, and at the same time as a people that had little regard to truth; witness the *credat Judaeus* of Horace, and the *qualiacunque voles* of Juvenal.

PAGE 260, l. *last*.

Began a very fine psalm. It were to be wished for the honour of religion, that many authors, particularly the legendary writers, had not so often exposed it to the raillery of infidels, by detailing an infinity of pretended miracles performed by their saints, often still more puerile than those in the text.

PAGE 264, l. 10.

Which is nothing but the web of a beetle. It is not the coque of a beetle; that berry is the animal itself, which is probably of the kind called by Reaumur Pro-gall-insects. See the notes, Pages 421, 422, and 423.

PAGE 266, l. 23.

Consider as a being possessed of omnipotence. It appears to me that people who think thus, although they deny that there is a God, are not, properly speaking, Atheists; because to acknowledge that nature is omnipotent, and that she governs the universe at her will, is in effect acknowledging nature for the deity under another name. The error of those who entertain such an idea, is like that of a foreigner who, seeing in a state where the king was invisible, that a single minister governed the kingdom, should deny that there was a king in the country, and should maintain that the minister was invested with despotic power; such a foreigner while he denied the existence of the regal state would however acknowledge a real king in the person of his minister, since he would attribute to him the whole royal authority. Indeed, if the apostle said of the heathen who worshipped those that by nature were not God, that they were without God, and without hope in the world; because with regard to consequences, to deny a deity and to acknowledge false Gods is one and the same thing; we may pronounce the same judgement on those mentioned by our author; and it is in this improper sense that they may well be called Atheists; the more, as they pay no worship to nature whom they exalt into a Deity.

FINIS.